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SERIALS

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California, Dept. of Water Resources, Bulletin. [Sacramento?].
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Ontario, Dept. of Mines, Preliminary Map. Toronto.
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South Carolina, State Development Board, Division of Geology, Bulletin; Geologic Notes. Columbia.
South Dakota Academy of Science, Proceedings. Vermillion.
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U.S. Geological Survey, Bulletin; Mineral Investigations Map; Miscellaneous Investigations Map; Professional Paper; Reports, Open-File Series. Washington, D.C.
Virginia Minerals (Virginia, Dept. of Conservation and Development, Division of Geology). Charlottesville.

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GeoScience Abstracts

1. GEOLOGIC MAPS, AREAL AND REGIONAL GEOLOGY

PART 1. GEOLOGIC MAPS

See also: Areal and Regional Geology 3-1399, 3-1400, 3-1402, 3-1403, 3-1414; Geophysics 3-1546; Geohydrology 3-1681, 3-1682, 3-1683, 3-1685, 3-1686, 3-1687.

3-1382. Canada, Geological Survey. MAGNETIC ANOMALY EAST OF QUINN LAKE, DISTRICT OF MACKENZIE, NORTHWEST TERRITORIES: Its: Geophysics Paper 1027, aeromagnetic map, scale 1:31,680, contour intervals 50, 100, and 500 gammas, lat. 61°-61°15'N., long. 107°37'30"-107°52'30"W., 1961.

3-1383. Ontario, Dept. of Mines. FOX: Its: Prelim. Map P. 99, scale 1 in. to 1/4 mi., 1961.

3-1384. Ontario, Dept. of Mines. MORTIMER: Its: Prelim. Map P. 101, scale 1 in. to 1/4 mi., 1961.

3-1385. Ontario, Dept. of Mines. STIMSON: Its: Prelim. Map P. 100, scale 1 in. to 1/4 mi., 1961.

3-1386. Ontario, Dept. of Mines. METROPOLITAN TORONTO, BEDROCK CONTOURS: Its: Prelim. Map P. 102, scale 1 in. to 2,000 ft., 1961.

This map has been compiled from data from bedrock outcrops and from over 1,400 boreholes. More than half the boreholes shown are located S. of Queen Street; thus the bedrock surface in the downtown area is known in considerable detail. However, large areas elsewhere in metropolitan Toronto have little or no data. This largely reflects a great thickness of overburden and a lack of major engineering works. --Ontario Dept. Mines.

3-1387. Canada, Geological Survey. CORONATION MINE AREA, SASKATCHEWAN AND MANITOBA: Its: Geophysics Paper 1028, aeromagnetic map, scale 1:31,680, contour intervals 10, 20, 100, and 500 gammas, lat. 54°30'-approx. 54°42'N., long. 101°50'-102°10"W., 1961.

3-1388. Petersen, Richard G., and John D. Wells. PRELIMINARY GEOLOGIC MAP OF THE EMMETT WASH NW QUADRANGLE, COCONINO COUNTY, ARIZONA: U.S. Geol. Survey, Mineral Inv. Map MF-197, scale 1:24,000, lat. 36°37'30"-36°45'N., long. 111°52'30"-112°W., 1960, pub. 1961.

3-1389. Peterson, Nels P. PRELIMINARY GEOLOGIC MAP OF THE PINAL RANCH QUADRANGLE, ARIZONA: U.S. Geol. Survey, Mineral Inv. Map MF-81, scale 1:24,000, lat. 33°15'-33°22'30"N., long. 110°52'30"-111°W., 1961.

3-1390. Robeck, Raymond C. MAP 10, DAKOTA STRUCTURE CONTOUR MAP, DOUGLAS CREEK AREA, COLORADO: scale 1 in. to 1 mi., The Author, 535 Orchard Ave., Grand Junction, Colorado, 1961.

Map shows the following: 1) 500-ft. structure contours drawn on top of Dakota sandstone [Cretaceous]; faults; 2) sections, drainage pattern, roads, townships and ranges, degrees, main mountains, washes, county lines; 3) location of all wells drilled for oil and gas, indicating dry hole, gas well, oil well; elevation of Dakota. The map is also available without the well data as Map 14.

Published separately is Chart 12, North-South Cross-Section, Douglas Creek Area, Colorado, with a vertical scale of 1 in. to 500 ft. It shows 27 wells along the crest of Douglas arch; operator and farm number; tops of all formations as reported by operators; major folds; sea level line; Kelly bushing elevation; total depth; gas-producing zones.--From auth.

3-1391. Robeck, Raymond C. MAP 11, MANCOS B STRUCTURE CONTOUR MAP, HORSE DRAW AREA, COLORADO: scale 2 in. to 1 mi., The Author, 535 Orchard Ave., Grand Junction, Colorado, [1961].

Map shows the following: 1) 100-ft. structure contours drawn on top of Mancos B sandstone [Cretaceous]; faults; 2) sections, drainage pattern, roads, townships and ranges, degrees, main mountains, washes, county lines; 3) location of all wells drilled for oil and gas, indicating dry hole, gas well, gas show, oil well; operator and farm number shown with elevation of top of Mancos B (Emery). The map is also available without the well data as Map 15.

Published separately is Chart 13, East-West Cross-Section, Horse Draw Area, Colorado, with a vertical scale of 1 in. to 500 ft. It shows 22 wells along the crest of the E.-W. anticline; operator and farm number; tops of all formations as reported by operators; major folds; sea level line; Kelly bushing elevation; total depth; gas-producing zones.--From auth.

3-1392. U.S. Geological Survey. VICKSBURG NATIONAL MILITARY PARK, MISSISSIPPI: scale 1:9,600, contour interval 10 ft., 1935, reprinted 1961.

3-1393. Willden, Ronald. PRELIMINARY GEOLOGIC MAP OF HUMBOLDT COUNTY, NEVADA: U.S. Geol. Survey, Mineral Inv. Map MF-236, scale 1:200,000, contour interval 200 ft., lat. 41°-42°N., long. 117°-119°W., 1961.

3-1394. Hotz, Preston E., and Ronald Willden. PRELIMINARY GEOLOGIC MAP AND SECTIONS OF THE OSGOOD MOUNTAINS QUADRANGLE, HUMBOLDT COUNTY, NEVADA: U.S. Geol. Survey, Mineral Inv. Map MF-161, scale 1:48,000, lat. 41°-41°15'N., long. 117°15'-117°30'W., 1960, pub. 1961.

3-1395. Pincus, Howard J. ENGINEERING GEOLOGY OF THE OHIO SHORE LINE OF LAKE ERIE. SHEET B - 83°00' TO 82°30' WEST LONGITUDE: Ohio, Div. Shore Erosion, Tech. Rept. no. 7, 1 sheet with 5 maps, secs., diags., graphs, text, 1960, 26 refs.

Second in a series of 7 maps (Sheet A, GeoScience Abstracts 3-376; Sheet C, see below; remaining 4 maps in process of publication) giving information on shorelines and offshore deposits and a description of shore types. Six figures give more detailed information of selected profiles; wind, wave and current observations at East Harbor; core logs at East Harbor; core logs and cross-section from Sandusky to Cedar Point; and an isometric panel section at Kelleys Island. Seven general figures show location, wind data, wave energy data, physiography, geology, lake levels, and soils. The text accompanying the map gives more detailed notes on bedrock (Silurian and Devonian carbonates and shales) underlying the area; features and surficial deposits landward of the shoreline; shoreline features and deposits; nearshore and island features and bottom deposits; littoral drift; inferred sources of beach building materials; hydrology; and lake levels.--J.R. Hyland.

3-1396. Pincus, Howard J. ENGINEERING GEOLOGY OF THE OHIO SHORE LINE OF LAKE ERIE, SHEET C - 82°59' TO 82°40' WEST LONGITUDE, SHORELINE OF SANDUSKY BAY: Ohio, Div. Shore Erosion, Tech. Rept. no. 8, 1 sheet with 7 maps, secs., diags., profiles, graphs, text, 1960, 27 refs.

Third in a series of 7 maps (Sheet A, GeoScience Abstracts 3-736; Sheet B, see above; remaining 4 maps in process of publication) giving information on shorelines and offshore deposits and a description of shore types. Seven figures show the buried valley system, details of boring logs in the area, cross-section from Marblehead to Cedar Point, and beach profiles. The text summarizes notes on bedrock (in area of Silurian - Devonian contact); features and surficial deposits landward of the shoreline; shoreline features and deposits; nearshore features and bottom deposits; littoral drift; inferred sources of beach building materials; hydrology of Sandusky River; and lake levels. Seven general figures show location, lake levels, and soils of the general area. J.R. Hyland.

3-1397. Berryhill, Henry L., Jr. GEOLOGY OF THE CENTRAL AGUIRRE QUADRANGLE, PUERTO RICO: U.S. Geol. Survey, Misc. Inv. Map I-318, scale 1:20,000, contour interval 10 m., lat. 17°52'30"-18 N., long. 66°07'30"-66°15'W., 1960, pub. 1961.

Folded Cretaceous volcanic sediments interbedded with lava flows are exposed in the foothills of the Cordillera Central. These are overlain by unconsolidated clastic sediments mapped as alluvium, fanglomerate, beach and lagoonal sediments. A fringing coral reef has been mapped along the coast. Crushable volcanic rock, sand, and gravel are the only deposits of economic value in the area.--U.S. Geol. Survey.

3-1398. Bramkamp, R.A., and Leon F. Ramirez. GEOGRAPHIC MAP OF THE JAWF-SAKAKAH QUADRANGLE, KINGDOM OF SAUDI ARABIA: U.S. Geol. Survey, Misc. Inv. Map I-201B, scale 1:500,000, lat. 28°-32°N., long. 39°-42°E., 1960, pub. 1961.

PART 2. AREAL AND REGIONAL GEOLOGY

See also: Sedimentary Petrology 3-1658.

3-1399. Douglas, R.J.W., and D.K. Norris. VIRGINIA FALLS AND SIBBESTON LAKE MAP-AREAS, NORTHWEST TERRITORIES: Canada, Geol. Survey, Paper 60-19, 26 p., 2 figs., 2 maps (Maps 22-1960 and 23-1960, scale 1:253,440, in pocket) 1960, 10 refs.

Map-areas include part of the western Interior Plains, the southern elements of Franklin Mountains, Mackenzie Plain, Mackenzie Mountains and the northern elements of the Liard Plateau. Rocks are Paleozoic in age, ranging from the Ordovician Sunblood limestone to the Upper Cretaceous Fort Nelson sandstone. Cretaceous rocks underlie the plains and occupy synclinal basins and troughs in the more mountainous folded part of the region. Thrust sheets, faulted folds, and broad, elongate uplifts and depressions are the principal structural elements. Many of the ranges are underlain by major thrust faults. Stratigraphic relations are such that traps for the accumulation of oil and gas are structurally possible. The main structural features are described in some detail. Pb, Zn, and Cu minerals are known to occur within the areas.--M. Stewart.

3-1400. Steven, Thomas A. GEOLOGY AND FLUORSPAR DEPOSITS, NORTHGATE DISTRICT, COLORADO: U.S. Geol. Survey, Bull. 1082-F, p. 323-422, 2 illus., 11 maps (4 geol. maps, in pocket), 2 tables, 1960, 58 refs.

The Northgate district in northern Colorado embraces the NE. corner of North Park and the adjacent western flank of the Medicine Bow Mountains. Metamorphic rocks in the mountains consist principally of hornblende gneiss, quartz monzonite gneiss, pegmatite, biotite-garnet gneiss, hornblende-biotite gneiss, and mylonite gneiss. These are cut by a quartz monzonite stock and by some local dacite porphyry dikes. Folded Permian and Mesozoic sedimentary rocks underlie North Park, and Tertiary White River and North Park formations fill valleys cut in the mountains.

Laramide deformation compressed the sedimentary rocks underlying North Park into NW.-trending folds. Many anticlines are cut by reverse faults, and North Park is cut off on the N. by the Independence Mountain reverse fault. The Northgate district may have been deformed in middle Tertiary time, but a more definite period of deformation took place in Pliocene time when 4 N.- to NW.-trending faults formed in the mountain area.

The White River formation in early Oligocene covered a hilly terrain drained by southward flowing streams. By late Miocene, northward flowing streams had cut deeply, and during late Miocene and early Pliocene(?) time, the Northgate area was again buried by the North Park formation. Subsequent erosion cut a surface of low relief now represented by the crest of the Medicine Bow Mountains.

The commercial fluorspar occurs along 2 of the late Tertiary faults. It consists typically of botryoidal layers that formed as successive encrustations along open fractures, or as finely granular aggregates replacing and cementing fault gouge and White River formation.--Auth.

3-1401. Dyson, James L. THE GEOLOGIC STORY OF GLACIER NATIONAL PARK: Glacier Nat. History Assoc., Spec. Bull. no. 3 [rev.], 24 p., illus., maps, secs., 1960.

A popular account of the geology of Glacier National Park, Montana. Included are descriptions of the Belt formations, igneous rocks of the Belt series, Cretaceous rocks, the Lewis overthrust, Pleistocene glaciation, and Recent modifications.--M. Russell.

3-1402. Heinrich, E. Wm., and John Charles Rabbitt. PRE-BELTIAN GEOLOGY OF THE CHERRY CREEK AND RUBY MOUNTAINS AREAS, SOUTHWESTERN MONTANA. PART 1. GEOLOGY OF THE CHERRY CREEK AREA, by E. Wm. Heinrich and John Charles Rabbitt. PART 2. GEOLOGY OF THE RUBY MOUNTAINS, by E. Wm. Heinrich: Montana, Bur. Mines & Geology, Mem. no. 38, 40 p., 9 figs., 4 pls. incl. illus., 2 geol. maps (in pocket), scale 1 in. to 1/2 mi., 4 tables, 1960, 50 refs.

Pt. 1. The area is underlain chiefly by a folded complex of metamorphic rocks belonging to the Cherry Creek group, which westward pass unconformably beneath the Cambrian Flathead quartzite and younger Paleozoic formations. The southernmost part of the area mapped, S. of Wall Creek, is underlain by granite gneiss. On the E. the pre-Beltian rocks are overlapped by a series of prominent river terraces of alluvium, out of which small knobs of metamorphic rocks protrude in a few places. Locally the pre-Beltian rocks are capped by remnants of lava flows (chiefly rhyolitic) and by thin sheets of travertine.

The Cherry Creek rocks were intruded by sills of granite, later metamorphosed to granite gneiss, and by sills and dikes of pegmatite, of which there are both foliated and nonfoliated representatives. Quartz veins also are abundant, particularly S. of Ruby Creek.

The Cherry Creek was defined by Peale as consisting of a series of marbles and interlaminated mica schists, quartzites, and gneisses not less than several thousand feet thick. The detailed rock sequence is much more complex and will differ considerably, depending upon the exact place of measurement, for there is a marked variation in petrology along the strike of some units at this locality. A layer of quartzite and an overlying thicker band of marble become thinner and pass northeastward into phyllite, and there are other similar gradations of a minor nature. These changes reflect original sedimentary differences, i.e., facies changes.

Another peculiarity of the type section is the close association of phyllite with such higher grade rocks as kyanite schist. In general the grade of metamorphism increases slightly northward. Between Wall and Ruby creeks, shales have been metamorphosed chiefly to phyllites; along Cherry Creek phyllites, mica schists, and kyanite schists occur together; but N. of Sunrise Gulch phyllites are totally absent, and sillimanite first appears about a mile N. of Morgan Gulch. Although these phyllites commonly contain biotite, they are nevertheless still very fine-grained rocks. Garnets also become much more abundant and coarser northward.

The Cherry Creek layers have been deformed into a large complex fold whose axial plane, in the general vicinity of Sunrise Gulch, strikes N. 20°-40° E. The southern limb, exposed from Johnny Gulch to above Cherry Creek, dips in general to the SE. The northern limb, S. of Wigwam Creek, appears to be generally vertical. The eastern part of the fold is not exposed, being covered by the alluvial terrace gravels.

No major faults occur in the area, but small slips with minor displacement occur within several of the units. Jointing is locally conspicuous in some of the more massive rocks, such as amphibole gneisses.--From p. 1-2, 4.

Pt. 2. The area mapped is underlain by 3 main units, which in general strike parallel with the range axis, i.e., NE.-SW. The southeasternmost unit consists of an isoclinally folded group of gneisses and subordinate schists, which, based on stratigraphic position and lithology, represent a distinct pre-Cherry Creek group of rocks. The northwestern belt consists mainly of Cherry Creek group rocks, and these 2 units are separated by a thick intrusive mass of granite gneiss, named the Dillon granite gneiss, by the writer.

These units have been intruded by usually small, irregular, and widely scattered pods and tabular bodies of peridotite, the largest of which is Wolf Creek pluton. Transecting all units, including the peridotites, is a group of diabase dikes that strike generally northwestward across the metamorphic layers. Small remnants of formerly much more extensive Tertiary lava flows cap the pre-Beltian rocks.

The sequence of pre-Beltian units is:

6. Diabase dikes
5. Peridotite intrusives
4. Aplites, pegmatites, quartz veins
3. Dillon granite gneiss
2. Cherry Creek group
1. Pre-Cherry Creek rocks

The pre-Cherry Creek rocks have an exposed outcrop width of about 5 mi., but its true thickness is difficult to estimate accurately owing to considerable isoclinal folding and lack of distinctive units. The belt of Cherry Creek rocks has a maximum thickness of about 4 mi., but this includes about 10% of intruded Dillon granite gneiss. The maximum width of the Dillon granite gneiss wedge is nearly 5 mi.--From p. 16.

3-1403. Johns, Willis M. **PROGRESS REPORT ON GEOLOGIC INVESTIGATIONS IN THE KOOTENAI-FLATHEAD AREA, NORTHWEST MONTANA. 2. SOUTHEASTERN LINCOLN COUNTY: Montana, Bur. Mines & Geology, Bull. 17, 52 p., 7 figs., 4 geol. maps (in pocket), 1960, 14 refs.**

The mapped area embraces approximately 800 sq. mi. of mountain terrain of the Purcell, Selish, and Cabinet ranges within the 30-min. Thompson Lakes quadrangle. The quadrangle, similar in lithology and structure to the Libby and Yaak River quadrangles, is underlain by argillites, quartzites, and limestones of the Precambrian Belt series. These sedimentary rocks are subdivided into 5 major conformable groups. They are the Prichard argillite of the pre-Ravalli group, the Ravalli quartzite of the Ravalli group, the Wallace limestone and argillite of the Piegan group, and the Striped Peak quartzite and Libby argillite of the Missoula group. Rather rapid although gradational changes in color and lithology occur along the strike in the Wallace and Striped Peak formations.

Igneous rocks are present in the northwestern part of the quadrangle as a small pyroxenite stock and as sills and dikes of metadiorite, diorite, and porphyritic quartz latite. Igneous rocks are absent in the other parts of the quadrangle.

Folding and faulting attributed to the Laramide orogeny has buckled the Belt sediments into moderate and broad NW.-trending anticlines and synclines which are displaced by NW. and E.-W. faults. Subsidiary faults strike NE. and N.

Au-quartz, Ag-Pb-Zn, W-quartz, and Cu veins occur as lodes in the mapped area. Some Au placers have been productive, although production from these properties has been limited. Vermiculite is mined from the Rainy Creek stock NE. of Libby.--Auth.

3-1404. New Mexico Geological Society. **GUIDEBOOK OF THE RIO CHAMA COUNTRY. ELEVENTH FIELD CONFERENCE, OCTOBER 14, 15, AND 16, 1960. Edited by Edward C. Beaumont and Charles B. Read: 129 p., illus., maps (geol. map in pocket, scale 1:250,000), secs., 1960, refs.**

This field conference investigated the general geology of parts of 3 rather distinct structural provinces - the great Rio Grande structural trough, or complex graben, the southwestern prong of the Rocky Mountain System, and the marginal areas of the Colorado Plateaus.

The first day of the field conference dealt principally with 2 of these provinces, the Rio Grande trough and the Brazos uplift, which are a part of the Rocky Mountain system. The remainder of the trip was in and adjacent to the Rio Chama country, most of which is situated in areas in or marginal to the Colorado Plateaus.

Although immediately adjacent to the San Juan basin, one of the larger subdivisions of the Colorado Plateaus and one of the great petroleum provinces of the Southwest, the Chama River country has lagged behind in resources development. Although known for many years to contain some commercial pools, exploration until very recently has been fraught with disappointments. Apparently at least some of the keys to discovery have now been found.--From foreward.

The guidebook contains 3 road logs (Taos to Chama, Chama to Parkview, Chama to Cuba), 9 geologic papers (abstracted separately below in the order in which they appear in the volume) and 2 papers of general interest (Early Explorations of Rio Arriba County, New Mexico, and Adjacent Parts of Southern Colorado, by Carle H. Dane; The Jicarilla Apache Indians of Northern New Mexico, by Sidney R. Ash).

3-1405. Muehlberger, William R. PRECAMBRIAN ROCKS OF THE TUSAS MOUNTAINS, RIO ARRIBA COUNTY, NEW MEXICO (In: New Mexico Geological Society. Guidebook of the Rio Chama Country: p. 45-47, 1960) 5 refs.

Au, Ag, and mica pegmatites have been important economic products from the Precambrian rocks in the Tusas Mountains. The oldest rocks, the Ortega quartzite, consist of 14,000-20,000 ft. of cross-bedded quartzite and pebbly quartzite, bearing kyanite and muscovite as accessory minerals, and with thin layers of amphibolite. Several thousand feet of greenschist and amphibolite, with minor amounts of conglomerate, phyllite, gneiss, and schist compose the Moppin metavolcanic series.

The Kiawa Mountain formation, about 10,000 ft. thick, consists of 5 members in the Las Tablas quadrangle: the Big Rock conglomerate, the Jawbone conglomerate, an amphibolite member, and 2 quartzite members. The Big Rock conglomerate overlies the Ortega quartzite and is the basal member of the Kiawa Mountain formation. This is overlain in turn by the lower quartzite member, the amphibolite member, and the upper quartzite member. The Jawbone conglomerate member lies on the Moppin metavolcanic series and is overlain by the upper quartzite member of the Kiawa Mountain formation.

The Petaca schist is a muscovitized variant of parts of the rocks described above and the included layers of Burned Mountain metarhyolite. It is the host rock of most of the Petaca pegmatites.

The preorogenic Burned Mountain metarhyolite occurs as tabular sills, dikes, and irregular masses. The synorogenic Maquinita granodiorite is well foliated and occurs as small plutons. The post-orogenic Tres Piedras granite is of 2 types: 1) pinkish, foliated, fine- to medium-grained granite; and 2) a porphyritic variety containing phenocrysts of microcline and quartz.--Auth.

3-1406. Romer, Alfred S. THE VERTEBRATE FAUNA OF THE NEW MEXICO PERMIAN (In: New Mexico Geological Society. Guidebook of the Rio Chama Country: p. 48-54, map, 1960) 21 refs.

The only Paleozoic vertebrate assemblage of New Mexico worthy of note is that of the early Permian Abo and Cutler formations, mainly known from 2 areas in the Chama River drainage in Rio Arriba County. This is a fauna of reptiles, amphibians, and sparse fishes, broadly similar to that of the Wichita group red beds of the early Permian of N.-central Texas. Collections are chiefly from the Arroyo de Agua locality, as well as sparse faunas from El Cobre Canyon near Aliquiu, Jemez Springs, upper Pecos Valley, and Arroyo de la Parida near Socorro.

A general resemblance between the New Mexico fauna and the Wichita group fauna is readily apparent; however, almost no species appear to be common to the 2 faunas. The Abo-Cutler sediments are of the typical red-beds type, indicative of at least seasonal aridity, whereas the Wichita red beds occur interbedded with variegated carbonaceous clays indicating less arid conditions; this difference is reflected in the sparse representation of aquatic forms in the Abo-Cutler red beds. The picture is one of 2 essentially contemporaneous faunas, evolving along similar lines but differing in a fashion to be expected of continental assemblages separated from one another by a broad water barrier.

The main faunal zone appears to be equivalent to the Putnam formation of the Texas Wichita group, which lies somewhere above the middle of the Wolfcampian; a higher faunal zone may be compared with the Admiral-Belle Plains assemblage (upper Wichita group), which lies close to the Wolfcamp-Leonard boundary; whereas the El Cobre Canyon fauna is probably of relatively early Wolfcampian age.--F. E. Kottlowski.

3-1407. Colbert, Edwin H. TRIASSIC ROCKS AND FOSSILS (In: New Mexico Geological Society. Guidebook of the Rio Chama Country: p. 55-62, 5 illus., chart, 1960) ref.

The Triassic sediments of northern New Mexico, in which stream channel and pond deposits are of prime importance, are a variegated sequence of sandstones, siltstones, and clays about 700 to 800 ft. thick. The rocks are included within the Chinle formation, subdivided into the basal Agua Zarca sandstone member, the Salitral shale tongue, the Poleo sandstone member, and the upper Petrified Forest member. The Chinle rests unconformably upon the underlying Cutler (or Abo) formation of Permian age, and is overlain, along a channeled contact, by the Jurassic cliff-forming Entrada sandstone. Most of the vertebrate fossils are found in the Petrified Forest member.

The fauna is largely of reptiles with some amphibians and fish. Phytosaurus, a crocodile-like reptile, Typothorax, an armored vegetarian, Coelophysis, a small bird-like dinosaur, and Eupelor, a giant amphibian, characterize the fauna. Coelophysis and Typothorax lived on higher ground between watercourses, whereas the phytosaurs and amphibians lived along streams and in ponds amid jungles of auracaria-like trees and ferns, and fed largely upon fish - the heavily scaled holosteans and their relatives. The environment was not unlike some modern tropical regions, for example, the Amazon basin.

The Chinle vertebrates belong to a widely spread fauna that occupied most of North America during late Triassic time; this fauna characterizes the Dockum beds of Texas, the Popo Agie beds of Wyoming, the Newark beds of eastern North America, and the classic Keuper of Europe.--F.E. Kottlowski.

3-1408. Dane, Carle H. THE DAKOTA SANDSTONE AND MANCOS SHALE OF THE EASTERN SIDE OF SAN JUAN BASIN, NEW MEXICO (In: New Mexico Geological Society. Guidebook of the Rio Chama Country: p. 63-74, 10 figs. incl. illus., maps, secs., 1960) 14 refs.

In the northeastern part of the San Juan basin, New Mexico, the Dakota sandstone of Late Cretaceous age is about 200 ft. thick. It is overlain by 2,000 ft. of Mancos shale divided into 5 members, successively upward, the Graneros shale, Greenhorn limestone, Carlile shale, Niobrara calcareous shale, and an unnamed upper member. Beds of Niobrara age in the northeastern part of the basin rest on an unconformity, which is represented by about 400 ft. of beds in the southern part of the basin, including much of the Gallup sandstone. Other stratigraphic changes from SW. to NE. are principally those that result from the northeastward thinning and termination of tongues of littoral and offshore sandstones that form part of the Mesaverde group of the southern part of the basin.--Auth.

3-1409. Simpson, George Gaylord. LATE CRETACEOUS AND EARLY CENOZOIC IN THE SAN JUAN BASIN (In: New Mexico Geological Society. Guidebook of the Rio Chama Country: p. 75-77, fig., 1960)

Northwestern New Mexico is famous as one of the few places where the Mesozoic-Cenozoic boundary has been precisely established in continental sediments. It also has the type provincial stage sequence for most of the American continental Paleocene. These classic strata occur along an arc of exposures from Aztec to Cuba.

The continental late Cretaceous overlies the Pictured Cliffs sandstone in the W. and the Lewis shale in the E.; the lower part consists of the upper Kirtland formation, and the lower coal-bearing Fruitland formation. The formations thin and the coals pinch out eastward, so that the eastern remnant near Cuba is called the Kirtland formation. The upper part of this late Cretaceous continental sequence is called the Ojo Alamo sandstone (including some thick clay lenses). All 3 units contain essentially the same fauna of turtles, crocodiles, and dinosaurs.

The lower and middle Paleocene is included in the Nacimiento formation with a lower Puerco fauna and an upper Torrejon fauna. These are the type faunas of the early and middle Paleocene and are chiefly of mammals. Contact of the Nacimiento clays on the Ojo Alamo sandstone is everywhere a sharply defined disconformity, and near Cuba the disconformity involves a hiatus representing the Puerco faunal zone. Above the Nacimiento near Cuba is the San Jose formation containing an early Eocene mammalian fauna; beds of the Tiffany formation, which occur to the N. and bear late Paleocene mammals, are absent near Cuba.

To the N., near Ignacio, Colorado, the Fruitland to Nacimiento sequence evidently grades laterally into the Animas formation of late Cretaceous and early Tertiary age, and the Animas andesitic strata underlie the Tiffany beds.

The sediments and their relationships suggest that the Laramide mountain-making began in this area in early Eocene time, with major deformation occurring after deposition of the San Jose formation. --F.E. Kottlowski.

3-1410. Budding, A.J., and others. GEOLOGY OF THE SOUTHEASTERN PART OF THE CHAMA BASIN (In: New Mexico Geological Society. Guidebook of the Rio Chama Country: p. 78-92, map, table, 1960) 33 refs.

The Chama basin is a shallow structural basin, which merges to the NW. with the much larger San Juan basin. In the SE. part of the basin, in an area bounded by 36°15'-36°30'N. 106°15'-106°37'30"W., the oldest exposed bedrock consists of Pennsylvanian siltstones. These rocks are overlain by the Permian Cutler formation (a composite section of 1,533 ft. is given in the appendix), the Triassic Chinle formation, the Jurassic Entrada, Todilto, and Morrison formations, and the Cretaceous Dakota(?) and Mancos shale formations.

Tectonic movements towards the close of the Mesozoic epoch continued into the Tertiary and resulted in a northwestern tilt of the Mesozoic and older sediments. The beveled edges of these sediments are unconformably overlain by the Eocene(?) El Rito conglomerate, the Miocene Los Pinos and Abiquiu tuff formations, and the Pliocene Sierra Negra basalt. Renewed deformation during the deposition of these Tertiary rocks caused tilting to the SE., rejuvenation of pre-Tertiary faults, and development of new faults. Solifluction and landsliding was pronounced under the periglacial conditions of the Pleistocene, and is still going on today.--Auth.

3-1411. Muehlberger, William R., and others. STRATIGRAPHY OF THE CHAMA QUADRANGLE, NORTHERN RIO ARRIBA COUNTY, NEW MEXICO (In: New Mexico Geological Society. Guidebook of the Rio Chama Country: p. 93-102, table, 1960) 33 refs.

The Chama quadrangle covers the central Chama platform and exposes a Mesozoic sedimentary section resting on Precambrian quartzite and, in one outcrop immediately E. of the quadrangle, on marine Pennsylvanian rocks. The latter consists of a basal talus overlain by hematite- and quartz-cemented sandstone. Above are arkosic sandstone, grayish-red siltstone, and gray nodular limestone (that contains a middle Des Moines fauna).

The Triassic Chinle formation unconformably lies on the Pennsylvanian of Chavez Canyon and elsewhere on the Precambrian quartzite. The overlying Jurassic Entrada sandstone is locally capped by thin gypsum and fetid limestone of the Todilto and Wanakah formations. The Morrison formation of lower fine-grained sandstone and an upper variegated mudstone completes the Jurassic section.

The Cretaceous Dakota formation, a three-fold unit of conglomeratic sandstone, dark shale, and sandstone, is conformably overlain by the marine Mancos formation which is here subdivided into 4 mappable members; the lowest, the Graneros shale, the Greenhorn limestone, the Carlile shale, and an upper shaly member.

The Mesaverde group is only 218-262 ft. thick, but the Point Lookout formation, Menefee formation, and the capping La Ventana tongue of the Cliff House sandstone are recognizable. The lower part of the Lewis shale is the youngest Cretaceous remaining after Laramide erosion.

The Blanco Basin formation (Eocene, Oligocene?) is an alluvial fan deposit that rests unconformably across the truncated edges of the older rocks and interfingers S. along the Brazos uplift with the El Rito formation. The Conejos quartz latite and the overlying Treasure Mountain rhyolite are the youngest Tertiary formations in the Chama quadrangle and vicinity.

Moraines and outwash terrace systems of the 3 glacial stages recognizable in the San Juan Mountains (Cerro, Durango, Wisconsin), extensive landslides, and Recent alluvial deposits constitute the Quaternary rocks.--Auth.

3-1412. Muehlberger, William R. STRUCTURE OF THE CENTRAL CHAMA PLATFORM, NORTHERN RIO ARRIBA COUNTY, NEW MEXICO (In: New Mexico Geological Society. Guidebook of the Rio Chama Country: p. 103-109, 3 maps, diag., 1960) 11 refs.

The Chama platform is an area of low structural relief except for anticlinal zones with less than 500 ft. of elevation. The platform is divided into 2 parts by the Brazos flaw, a W.-trending zone of structural dislocation; the southern part is broad, and is gently deformed with N.-trending folds and faults; the northern part is more highly deformed with NW.-trending folds and fault zones.

E. of the platform, structures turn sharply up to the Brazos uplift with as much as 5,000 ft. of structural relief. N. of the Brazos flaw, the N.-trending uplift is broken by NW.-trending faults that produce structurally high salients SW. of each major fault. S. of the flaw, the rim continues southward without any salients for over 15 mi.

W. of the platform, the Archuleta anticlinorium separates the Chama platform from the San Juan basin to the W. N. of the Brazos flaw, the anticlinorium consists of NW.-trending belts of folds. S. of the flaw, it is marked by a single N.-trending belt of tight anticlines that further S. steps westward to the Gallina uplift.

The observed structures are principally Laramide (pre-Blanca basin or San Jose; Eocene) and secondarily late Cenozoic features that have been superposed on late Paleozoic and Precambrian structures. The shapes of the folds are long, tight, and narrow so they must be disharmonic in depth and are probably allochthonous.--Auth.

3-1413. Bieberman, Robert A. EXPLORATION FOR OIL AND GAS IN THE CHAMA BASIN (In: New Mexico Geological Society. Guidebook of the Rio Chama Country: p. 110-112, table, 1960) 5 refs.

Oil and gas exploration in the Chama basin, encouraged by oil seeps and petroliferous residues in dikes, began in 1901 with a well that produced small quantities of oil. Sporadic drilling followed, but not until 1935 was the Gramps field found with production from the Dakota sandstone. The oil accumulated against a transverse fault crossing a N.-S. anticline. Total production to date has been about 5 million barrels. Oil was discovered on the Chromo anticline in 1947 and is being produced from fractures in the Mancos shale.

Stratigraphic and structural conditions within the area are favorable for the occurrence of oil. The 48 test wells drilled in the New Mexico part of the Chama basin have been dry but have not adequately checked the possibilities of: 1) areas of fractured Mancos shale, 2) Dakota sandstone in structurally high areas near faults or dikes, 3) pre-Dakota units such as the Entrada sandstone, Todilto limestone, and wedge-edges of the Permian and Pennsylvanian rocks.--Auth.

3-1414. Simpson, Howard E. GEOLOGY OF THE YANKTON AREA, SOUTH DAKOTA AND NEBRASKA: U.S. Geol. Survey, Prof. Paper 328, 124 p., 11 figs. incl. maps, secs., diags., graphs, 13 pls. (5 in pocket) incl. illus., geol. map, scale 1:48,000, 5 tables, 1960, 163 refs.

The Yankton area lies in southeastern South Dakota and northeastern Nebraska. Bedrock formations include the Sioux quartzite of Precambrian age, the Dakota sandstone of Early Cretaceous age, the Graneros shale, Greenhorn limestone, Carlile shale, Niobrara formation, and Pierre shale of Late Cretaceous age, and the Ogallala formation of Pliocene age. Deposits of Pleistocene age include interbedded till, loess, and outwash correlated with the Kansan and Illinoian stages, and the Iowan, Cary, and Mankato substages of the Wisconsin stage. Buried soils identified are of Sangamon, Farmdale, and Cary-Mankato age. Post-glacial accumulations include various mass-wasting, stream, and wind deposits.

In Early Cretaceous time continental sediments accumulated on the eroded surface of Precambrian rocks. During Late Cretaceous time an epeiric sea covered the region, and several hundred feet of marine sediments were deposited before the sea withdrew. Laminae in the Niobrara formation suggest that from time to time conditions of upwelling existed comparable to those that occur today off the southern California coast. In Tertiary time fluvial sediments were deposited on the eroded Cretaceous rocks, and during the Quaternary period conditions for erosion and accumulation of sediments alternated.

A series of drainage changes characterized geomorphic development. Glaciers blocked drainage and caused rivers to occupy, commonly temporarily, other channels beyond the ice margin. The Missouri River was formed in this way during Illinoian time.

Some natural resources, mainly sand and gravel, are presently available. Others, including limestone and shale for portland cement or shale and loess for light-weight aggregate, require additional investigation.--Auth.

3-1415. Dzvelaya, M. F. THE GEOLOGICAL STRUCTURE OF THE KOLKHID LOWLAND: Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in translation, v. 125, no. 1-6, p. 239-241, March-Apr. 1959, pub. 1960.

Stratigraphic, lithologic, and paleontologic studies of the Kolkhid lowland in Georgia, U.S.S.R., have been carried out on material from boreholes drilled in the course of oil prospecting. The strata investigated range from Quaternary to Lower Cretaceous in age. Maximum section was 3,300 m.

As a result of tectonic movements in W. Georgia, U.S.S.R., a progressively intense deformation of the beds is encountered with increasing age. The Cretaceous beds are particularly intensely deformed. --F. Manheim.

3-1416. Craddock, Campbell, and Harold A. Hubbard. PRELIMINARY GEOLOGIC REPORT ON THE 1960 U.S. EXPEDITION TO BELLINGSHAUSEN SEA, ANTARCTICA: Science, v. 133, no. 3456, p. 886-887, map, March 24, 1961, 5 refs.

Thurston Peninsula, although largely snow covered, exposes massive to foliated dioritic rock and schist exhibiting NE.-trending structures. One basalt pebble was found. The adjacent continental shelf is cut by submarine valleys. Peter I Island, a dissected basaltic volcano 250 mi. to the NE., was visited.--Auth.

2. GEOMORPHOLOGY

See also: Stratigraphy 3-1470, 3-1471; Paleontology 3-1534; Geochemistry 3-1612, 3-1613, 3-1624; Sedimentary Petrology 3-1651, 3-1660, 3-1661, 3-1665, 3-1669.

3-1417. GEOMORPHOLOGICAL ABSTRACTS. Edited by Keith M. Clayton: v. 1- , June 1960- in progress, Dept. of Geography, London School of Economics, Houghton Street, Aldwych, London, W.C. 2, England.

This new journal will be published 4 times a year, and at the start will cover about 350-500 articles in the year. The range of articles includes anything relevant to geomorphology, including marginal material on soils, glaciology, and similar topics. The present coverage is thought to include all important material from the British Commonwealth, most of Western Europe, and North America; the intention is to extend this range gradually to the whole world. All abstracts are published in English with translated titles, and they are usually specially prepared; only occasionally are the original author's abstracts reproduced. The abstracts are arranged by subject, and each year an author index and regional index will be provided.--From ed.

3-1418. Engelhardt, Donald W. A COMPARATIVE POLLEN STUDY OF TWO EARLY WISCONSIN BOGS IN INDIANA: Indiana Acad. Sci., Proc., v. 69, p. 110-118, 4 figs., 1959, pub. 1960, 12 refs.

Results obtained from the analysis of the Fox Prairie bog and Bacon's swamp exhibit a striking resemblance. The lower levels are characterized by a Picea-Abies climax with a Pinus maximum at the decline of this climax. In the following interval, which may be interpreted as the Two Creeks interval, there is a rapid and distinctive increase of the deciduous forest genera. The second Pinus maximum, in conjunction with Picea, Abies, and Tsuga, then occurs to close this interval. This coniferous increase may be due to the climatic effect of the Valders advance. After the decline of the conifers. Quercus and Carya become dominant and continue to the surface as the climax association. Acer and Fagus increase near the surface indicating another possible climatic change.

The postglacial forest succession of Picea-Abies to Pinus to the deciduous forest complex to Pinus-Picea-Abies to Quercus-Carya to Acer-Fagus suggests the following climatic periods: cool moist to cool drier to warmer drier, changing to cool moist again, and then to warm drier and finally to warm more moist.--Auth. summ.

3-1419. Enzmann, Robert Duncan. MORPHOLOGY OF FROST POLYGONS AS RELATED TO GROUND SLOPE IN EASTERN GREENLAND: Iowa Acad. Sci., Proc., v. 67, p. 357-361, illus., 1960, ref.

This paper describes polygonal frost-patterned ground on level terraces, modification of the polygons by solifluction to garlands on slopes of 5° to 35°, modification of the garlands to rock stripes on slopes of 20° to 45°, collapse of stripes into jumbled rock glaciers on slopes of 35° to 60°, or more commonly, modification of stone stripes back through the sequence of stripes and garlands where the slope shallows toward the valley floor. The subsurface structures of 8 polygons, 2 garlands, and 2 stone stripes were exposed by trenching. The garlands and stone stripes were on a slope lying between a flat-lying raised beach and a very slightly inclined valley floor. The trenching proved the rock-rimmed areas to be 3 dimensional with limited depth. Within each ring there was a vertical as well as horizontal sorting of soil, sand, and rock fragments, with the finest fractions toward the center.--Auth.

3-1420. Carson, Charles E., and Keith M. Hussey. HYDRODYNAMICS IN SOME ARCTIC LAKES: Iowa Acad. Sci., Proc., v. 67, p. 336-345, 2 maps, 2 diags., graph, 1960, 9 refs.

Two hypotheses concerning wind-driven current systems in Alaska's oriented lakes are discussed. The first describes end-currents in the lakes returning upwind due to a hydrostatic pressure gradient on the downwind side. The second describes end-currents flowing in a windward direction and being related to the angle at which the waves approach the shoreline near the ends. These hypotheses are evaluated in the light of recent field work designed to test them.--Auth.

3-1421. Sinitsyn, V.M. THE MONGOLO-SIBERIAN ANTICYCLONE AND THE REGIONAL ZONATION OF THE EOLIAN DEPOSITS OF CENTRAL ASIA: Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in translation, v. 125, no. 1-6, p. 308-310, map, March-Apr. 1959, pub. 1960.

The area of the Mongolian-Siberian barometric maximum has the highest atmospheric pressures in the world, reaching 810 mm. at Irkutsk. This area is also center for an intense anticyclonic circulation of the atmosphere, which has marked effects on the eolian deposits of central Asia. The immediate area of the anticyclone origin is characterized by sandy desert; in the next zone, winds reach maximum strength, and broad, stony deserts characterize the topography. Farther outward are again sandy deserts and extensive loess accumulations. From study of land forms and eolian deposits it is concluded that the Mongolo-Siberian anticyclone has existed throughout the postglacial epoch, i.e. the last 12,000-15,000 years.--F. Manheim.

3-1422. Moore, George W. INTRODUCTION TO THE ORIGIN OF LIMESTONE CAVES: Natl. Speleol. Soc., Bull., v. 22, pt. 1, p. 3-4, Jan. 1960.

This symposium [see following 8 abstracts] presents evidence bearing on cave origin derived principally from the shape and spatial relations of caves. The observations suggest that most limestone caves were formed in a zone of saturation directly below a nearly horizontal local or regional piezometric surface. Acids resulting from chemical and biochemical processes operating in this zone during oxidation of sulfide minerals and organic matter present in the limestone are thought to have made the zone especially favorable for cave development. --Auth.

3-1423. Davies, William E. **ORIGIN OF CAVES IN FOLDED LIMESTONE:** Natl. Speleol. Soc., Bull., v. 22, pt. 1, p. 5-18, 12 figs., 2 tables, Jan. 1960, 11 refs.

Investigation of caves in folded limestone of the Appalachian region reveals 5 distinct features bearing on the origin of solution caves: 1) cavern passages develop across the dip or parallel to the strike of the limestone and generally have uniform gentle slope independent of the rock structure; 2) many caves have passages on multiple levels, and, within a region, the separation of levels is uniform; 3) intervals between passage levels correspond closely to intervals between gravel benches on the flanks of major surface valleys in the cavern region; 4) major caves are along large valleys, and only small caves and solution pockets occur in upland areas away from major valleys; and 5) cavern passages decrease in size and become more numerous in the part of the cave away from major surface valleys.

The stages of cavern development in folded limestone beds probably are: 1) random solution at depth in a zone of saturation to produce nonintegrated solution tubes and pockets; 2) integration of tubes into mature caverns at the top of the zone of saturation during a period when the water table was uniform in altitude, and flow was constant for a long period of time (direction of flow was toward major valleys); 3) deposition of clastic fill under alternating conditions of saturation and aeration; and 4) relative uplift of the cave above the zone of saturation with modification of passages by deposition of speleothems, erosion to fill material, and collapse.--Auth.

3-1424. Bretz, J. Harlen. **ORIGIN OF BERMUDA CAVES:** Natl. Speleol. Soc., Bull., v. 22, pt. 1, p. 19-22, map, Jan. 1960, 3 refs.

Throughout Pleistocene time, the calcareous island group of Bermuda has repeatedly been partially inundated and emergent. The land areas have been continuously attacked and reduced by rain and ground water, but they have been recurrently renewed by deposition of marine limestone and, on surviving lands, of shore-borne and wind-transported carbonate sand, now eolianite. At present, the karst topography and the caves are largely below sea level, and their origin must date from times of continental glaciation. When the islands were larger because of lowered sea level, a lens of fresh ground water occupied the present position of the caves. Later rise of sea level destroyed these phreatic conditions, and the caves assumed their present state in which they are partly filled with salt water.--Auth.

3-1425. Halliday, William R. **CHANGING CONCEPTS OF SPELEOGENESIS:** Natl. Speleol. Soc., Bull., v. 22, pt. 1, p. 23-29, Jan. 1960, 13 refs.

Theories on the nature of the origin and development of limestone caverns underwent systematization in the United States in 1930 as a result of the publication of an important deductive study by William Morris Davis. For some years thereafter, controversy existed as to whether caves are a result of a "1-cycle" process occurring wholly in the vadose zone or a "2-cycle" process having its first phase in the phreatic zone. Field work by many investigators in recent years has indicated some features of caverns which clearly were formed in the phreatic zone and others which were formed in the vadose zone, but this has by no means resolved the controversy.

Comparison of the features of individual limestone caves with those of nearby caves that are at a different stage in a genetic sequence and comparison with caves in different regions suggest that the terms "1-cycle" and "2-cycle" should be abandoned. Emphasis instead should be placed on the specific nature of features of individual caves derived from processes occurring in each of the phreatic and vadose zones. Only in the broadest terms can it be said that all limestone caves develop in the same way, and terminology which suggests that this is true should be replaced by descriptions of individual speleogenetic sequences.--Auth.

3-1426. Deike, George H., 3d. **ORIGIN AND GEOLOGIC RELATIONS OF BREATHING CAVE, VIRGINIA:** Natl. Speleol. Soc., Bull., v. 22, pt. 1, p. 30-42, 13 figs., Jan. 1960, 6 refs.

Thirty or more caves occur in the folded Tonoloway, Keyser, and Helderberg limestones in the southwestward extension of a synclinal segment of the Bullpasture River valley in W.-central Virginia. The limestone formations, dipping less than 30°, plunge NE. beneath Devonian shale and are again exposed in Bullpasture Gorge water gap. Subterranean drainage crosses the structural grain and resurges at 4 springs in Bullpasture Gorge.

Breathing Cave, on the NW. side of the valley, in which 4 mi. of passages have been surveyed, is a rectangular maze of strongly joint-controlled passages in a limited stratigraphic zone. The cave is confined to a 77-ft. section of shaly limestone between 2 sandstone beds and is little affected by numerous minor folds and faults. It follows the dipping flanks of a syncline through a vertical range of 340 ft.

The major caves appear to have developed below the water table, in an artesian situation, confined by sandstone interbeds. Caves near spring outlets tend to be horizontal, regardless of the attitude of the bedding, and evidently they formed directly below the water table. Breathing Cave, which is far from the ground water outlet, exhibits deep bedding-controlled development, but it contains some evidence of horizontal enlargement caused by former stable positions of the water table.--Auth.

3-1427. White, William B. **TERMINATIONS OF PASSAGES IN APPALACHIAN CAVES AS EVIDENCE FOR A SHALLOW PHREATIC ORIGIN:** Natl. Speleol. Soc., Bull., v. 22, pt. 1, p. 43-53, 4 figs., table, Jan. 1960, 10 refs.

Considerable controversy exists between advocates of the deep phreatic theory of cave origin of Davis and Bretz and advocates of the shallow phreatic theory of Davies and Sweeting. The deep phreatic theory predicts cavern enlargement along any open conduit in a lithologically suitable bed without regard to depth below the water table. The shallow phreatic theory predicts solution only in a limited zone just below the water table. The latter theory was supported by evidence found in the examination of about 25 caves in the Appalachian Mountains.

Caves with maze patterns have apparently formed by slow phreatic flow along a soluble bed. In flat-lying limestone, caves with this pattern may have considerable area, but in strata of medium dip, passages on the updip and downdip sides terminate abruptly. Hence solution is limited to a narrow zone, even though the soluble bed continues in both directions. Several caves in nearly vertical limestone have been examined. In none of these had solution extended any distance along the bedding in a vertical direction, even though a favorable bed and good partings existed in that direction. Instead the caves are limited to a nearly horizontal zone. Cross sections of caves in steeply dipping limestone show that the passages tend to be elongated along layers of good solubility. In the updip direction the cross section narrows and pinches out. In the few caves where the cross section can be traced downdip, the same thing is observed.

These data show that caves tend to maintain their horizontal pattern in spite of structure and lithology. The position of the water table is apparently the dominant controlling factor; structure and lithology seem merely to modify the ground plan and passage cross section.--Auth.

3-1428. Thrailkill, John V. ORIGIN AND DEVELOPMENT OF FULFORD CAVE, COLORADO: Natl. Speleol. Soc., Bull., v. 22, pt. 1, p. 54-65, 5 figs., Jan. 1960, 13 refs.

Fulford Cave, a solution cave in the Leadville limestone, consists of a series of parallel passages which extend along the strike of the beds and which are connected at their northeastern ends by a passage parallel to the dip. This passage is occupied by a stream throughout most of its length. The known passages of the cave have an aggregate length of half a mile and the cave has a vertical extent of over 200 ft.

Although development of cavities occurred in the Leadville limestone during late Paleozoic time, these cavities have since been filled with detritus, and the present cave has been excavated more recently. Erosional and depositional features within the cave indicate that its present form is due to erosion and deposition in these 3 successive environments, of which the principal characteristics are: 1) conditions of slowly moving ground water far below the water table; 2) conditions of more rapidly moving ground water just below the water table; and 3) air filled conditions in which only vadose water is present. It is believed that the principal cave excavation occurred during the second of these environments, probably as the water table was intermittently lowered during Wisconsin time.--Auth.

3-1429. Curl, Rane L. STOCHASTIC MODELS OF CAVERN DEVELOPMENT: Natl. Speleol. Soc., Bull., v. 22, pt. 1, p. 66-76, 10 figs., table, Jan. 1960, 5 refs.

A population of caves evolves from a population of cave precursors consisting of joint systems of different complexity, which are subject to the invasion of solvent water whose source, composition, and availability vary in space and time. Although phenomenological theories have had considerable success in the identification and explanation of the succession of geomorphic processes responsible for cave development, these processes also produce manifestations in a cave population related to processes of a random or stochastic nature.

Stochastic models have been constructed to reproduce mathematically the evolution of a particular population manifestation, namely the distribution of cave lengths. Intuitively "simple" mechanisms for the rate of cave growth and decay have been used for this purpose. The theories provide a quantitative description of the evolution of cave length distributions and, conversely, some attributes of cave precursors which would lead to present-day length distributions. An estimate of the length distribution of all caves more than 100 ft. long in West Virginia is used for these comparisons.

The complexity of the evolutionary process of cave populations and the urge to select evolutionary mechanisms which are subjectively simple as well as mathematically tractable are perhaps contradictory, but stochastic-process concepts are essential for a more quantitative understanding of the cavern cycle, and simple models may serve as a point of departure. --Auth.

3-1430. Lange, Arthur L. GEOMETRICAL BASIS FOR CAVE INTERPRETATION: Natl. Speleol. Soc., Bull., v. 22, pt. 1, p. 77-84, 12 figs., Jan. 1960, 6 refs.

The shapes of cave structures can be a key to understanding the evolution of the cave, since they are the result of erosive and depositional processes acting on the cave boundaries. Any future outline of a uniformly dissolving or encrusting cross section of wall, ceiling, or floor is generated by a circle rolled with its axis everywhere in contact with the initial outline. The envelope described by the circle represents the new contour, and the radius is dependent on the mass transfer rate and the duration of the action. In the case of the 3-dimensional body, a generating sphere will yield the correct form. This procedure is a geometrical interpretation of the differential equations expressing the event.

Sharp projecting corners will remain sharp while dissolving and will round off when encrusted. Inside corners will round off under solution and remain sharp during deposition. The resultant topographies of complex wall pattern are typical of the scalloped solution-work and bulbous encrustation found in caves where corrasion, gravity, and other directional agents have not modified the basic mechanism.

Plane walls, inundated stalactites, and right-angled ceiling blocks serve as examples of simple geometrical structures. Solution pockets, mammillary crusts, domes, gours, crusted strands, and wall niches are examples of more complicated forms. A cave stream flowing normal to a cross section and an evenly circulating water body or film are cave media in which the process of uniform mass transfer can be closely approximated.--Auth.

3-1431. Howard, Arthur David. CENOZOIC HISTORY OF NORTHEASTERN MONTANA AND NORTHWESTERN NORTH DAKOTA WITH EMPHASIS ON THE PLEISTOCENE: U.S. Geol. Survey, Prof. Paper 326, 107 p., 44 figs. incl. illus., maps, profiles, secs., diags., graphs, 8 pls. (in pocket), 6 tables, 1960, 111 refs.

The study embraces an area of approximately 20,000 sq. mi. in the northern Great Plains. The widespread Missouri Plateau peneplain is surmounted by numerous plateau remnants and trenched by deep valleys. Exposed rocks range from Late Cretaceous to Oligocene. Surficial deposits include Tertiary stream gravels and glacial and nonglacial Quaternary sediments.

The older gravels form high divides and indicate reversals of topography. The gravels and upland swales indicate that the Missouri, Yellowstone, and Little Missouri rivers drained northward into Canada until blocked by Kansan, or possibly Illinoian ice.

During Yarmouth(?) time, the Missouri eroded a trench several hundred feet below the peneplain, almost to present river level (Crane erosion cycle). In the succeeding erosion cycle (deep-trench), the valley floor was trenched more than 100 ft. below present stream level. This was the topographic situation at the beginning of Wisconsin time. The master drainage was fully established except that the Little Missouri River still flowed N. into the Missouri.

The first Wisconsin glacier advanced 20 to 50 mi. S. of Missouri Valley. The displaced Missouri carved imposing channels along the ice front between large glacial lakes. Brief erosional intervals preceded the advance of the middle and late Wisconsin glaciers. The latter (Mankato glacier) deposited massive moraines in the northern part of the area. In late Mankato time a thick alluvial fill was deposited throughout the region. The age is suggested by remains of Bison antiquus(?). The older alluvium was later trenched and the trench occupied by recent alluvium.--Auth.

3-1432. Phillips, J. A., and F. F. Riecken. CHARACTERISTICS OF THE FLOYD AND SOME RELATED SOILS IN FLOYD AND BREMER COUNTIES, IOWA: Iowa Acad. Sci., Proc., v. 67, p. 277-289, 4 figs., 1960, 18 refs.

This study deals with imperfectly and poorly drained soils generally considered to have developed under prairie from a parent material consisting of a sandy-silt mantle overlying Iowan glacial loam till. Three Floyd profiles, 2 profiles of the proposed Tripoli series (Floyd, poorly drained variant), and one Clyde profile were studied in the field and in the laboratory. Results indicate that the Tripoli soils should be separated from the Floyd and mapped as a separate series. The present concepts of the Floyd series as a minimal Brunizem and the Tripoli as a minimal Wiesenboden are substantiated by field studies and laboratory data.--Auth.

3-1433. Riecken, F. F., and Ernst Poetsch. GENESIS AND CLASSIFICATION CONSIDERATIONS OF SOME PRAIRIE-FORMED SOIL PROFILES FROM LOCAL ALLUVIUM IN ADAIR COUNTY, IOWA: Iowa Acad. Sci., Proc., v. 67, p. 268-276, 4 figs. incl. map, 1960, 10 refs.

Data are presented on 3 profiles formed under prairie from late Wisconsin to Recent age local alluvium of moderately fine texture. In the upper 20 in. N and base saturation values are quite similar to those found for normative upland Brunizems. Below 20 to about 50 in., N and base saturation values decrease and increase, respectively, more slowly in the local alluvium-formed soils. It is suggested that the classic ABC soil genesis concept does not apply to the local alluvium-formed soils of this study. Rather, through cumulative effects of new parent material at the surface, this new C was transformed to an A^c horizon (c for cumulative effect), the former A_1 was transformed to a B^c horizon, and the former B became a substratum C^c horizon. Soil genesis effects in such cumulative soil genesis systems need further attention, as these soils comprise about 1/4 of the land area of Iowa, are important agriculturally, and an understanding will further knowledge of other soils of Iowa.--Auth.

3-1434. Brown, Cyril B. GENESIS OF LIMESTONE PROFILES IN THE TROPICS: Indiana Acad. Sci., Proc., v. 69, p. 286-289, table, 1959, pub. 1960, 5 refs.

None of the soils found on coral on Tobago, West Indies, are genetically related to the underlying coral. The shallow soils are entirely of volcanic ash origin. The deeper ones have been influenced by volcanic ash and volcanic detritus.

Detritus is even now being deposited on the surface of the deeper soils. The end product of weathering is kaolinite, while montmorillonite accumulates in the poorly drained soils. There is present in some horizons a mineral with maximum spread of spacing 7.13 Å to 7.62 Å which suggests a low hydration variety of halloysite. This mineral is associated with poor internal drainage. Similar conditions should exist throughout the West Indies where the red soils on coral may not be Terra Rossas, nor the dark ones Rendzinas although there are great similarities. An interesting side observation from the study is that the coconut palm will not tolerate high concentrations of montmorillonite.--Auth.

3-1435. Arnold, R. W., and others. ESTIMATE OF SLOPE CLASSES BY COUNTIES IN IOWA: Iowa Acad. Sci., Proc., v. 67, p. 260-267, map, graph, table, 1960, 6 refs.

The proportion of land in given slope classes has been estimated for Iowa counties from a randomly selected sample. The sample, approximately 2% of the land area of the state, consists of about 4,500 individual tracts, each about 160 acres in size. A detailed soil map was made of each tract, using a 4-in.-to-the-mi. aerial photograph as a base map, thus providing the basic information for a physical land-condition inventory. The data from the soil maps were projected to give estimates of physical land conditions by counties and for the state as a whole. On a state basis, nearly 60% of the state has slopes of less than 5% gradient, and almost 75% of the state has slopes of less than about 9% gradient. Summarized estimates of percent land in the 0-1, 2-4, 5-8, 9-13, 14-17, 18-24, and 24 plus percent slope classes are given for all counties of the state, and for the state.--Auth.

3-1436. Tanner, William F. FLORIDA COASTAL CLASSIFICATION: Gulf Coast Assoc. Geol. Soc., Trans., v. 10, p. 259-266, 3 maps, 2 tables, 1960, 11 refs.

A shoreline classification, based on the equilibrium concept, is developed in detailed. It is shown that the basis equilibrium notion can be supplemented, to good advantage, by the observation that downshore (i. e., littoral) changes in energy level or drift rates are important in shaping the coast. Other factors which are used in constructing the classification are tectonic stability, sea level stability, material present, and nonmarine agencies involved.

Most of the Florida E. coast is marked by high energy levels, the W. and panhandle coasts by low to moderate energy. Quartz sand, shell fragments, and exposed bedrock (limestone) are the dominant materials present. Maximum erosion is now occurring on the lower E. coast and on the central panhandle coast, where ramp slopes are steep (50 or more ft. per mi.), and on the lower W. coast, where there is essentially no supply of new sand for littoral drift. Violent, local erosion in other parts of the state is primarily a matter of readjustment in response to the activities of man.

The shoreline classification here applied cannot be used directly in paleogeographic interpretation. Much the same information can be obtained, however, by modern stratigraphic techniques.--Auth.

3-1437. Skinner, Hubert C. **A COMPARISON OF THE MISSISSIPPI SUBMARINE TRENCH WITH THE IBERIAN TROUGH: Gulf Coast Assoc. Geol. Soc., Trans., v. 10, p. 1-6, 4 maps, diag., 1960, 31 refs.**

The Mississippi submarine trench differs from other submarine valleys in being "trenchlike" with a broad, flat floor rather than "V-shaped." Domes and ridges stand out in topographic relief along the SW. margin of the trench; others, less prominent, lie along the NE. margin. These domes and ridges may be related to underlying salt structures.

The Iberian trough is flanked by the "Five Islands" along its SW. margin and by another series of domes along the NE. flank. The "Five Islands" are unique among onshore S. Louisiana salt domes in having pronounced topographic expression. They are described briefly to illustrate the similarity of the "Five Islands: and the Iberian trough to the Mississippi submarine trench and the salt domes along its margin. The 2 major structural troughs have the same trend and are in alignment. This similarity and their probable common or related origin are discussed.--Auth.

3-1438. Coogan, Alan H. **GEOLOGICAL AGE OF SOLDIER CREEK, BUFFALO COUNTY, SOUTH DAKOTA: Iowa Acad. Sci., Proc., v. 67, p. 314-325, 2 illus., 2 maps, 2 tables, 1960, 6 refs.**

A quantitative analysis of data derived solely from maps of Soldier Creek and a comparison with similar data from Good Soldier Creek show Soldier Creek to be a composite stream of several branches which differ in drainage composition and which therefore probably differ in origin. A study of the field evidence bearing on anomalous factors in the quantitative analysis shows Soldier Creek was formed by the capture of several post-Iowan streams by a younger post-Cary stream.--Auth.

3-1439. Rush, Richard W. **DRAINAGE DEVELOPMENT IN LOWER FRESNO CREEK AREA, PRESIDIO COUNTY, TEXAS: Iowa Acad. Sci., Proc., v. 67, p. 326-335, 4 illus., 2 maps, 1960, 7 refs.**

Comparison of landforms in adjacent watersheds shows stripped forms in lower Fresno Creek basin and alluvial forms in Lajitas basin. The hypothesis is presented that these landforms resulted from a sequence of stream captures in which Lajitas drainage diverted headwaters of Terlingua Creek, and that later capture of the same headwaters by Fresno Creek established modern drainage lines. Interpretation of the evidence shows that physical features of each basin result from specific factors, including stream energy, within each stream system.--Auth.

3. STRUCTURAL GEOLOGY

See also: Areal and Regional Geology 3-1412; Stratigraphy 3-1457, 3-1474; Geophysics 3-1568, 3-1581, 3-1582, 3-1583, 3-1585; Mineral Deposits 3-1695.

3-1440. Hughes, Dudley J. **FAULTING ASSOCIATED WITH DEEP-SEATED SALT DOMES IN THE NORTHEAST PORTION OF THE MISSISSIPPI SALT BASIN: Gulf Coast Assoc. Geol. Soc., Trans., v. 10, p. 155-173, 14 figs. incl. maps, secs., graphs, 1960, 6 refs.**

Faulting in the NE. portion of the Mississippi salt basin is principally of the local graben type resulting from salt doming. On deep-seated salt dome structures, the faulting appears to exhibit certain common characteristics throughout the area which can be applied to great advantage in subsurface interpretations.

The strike of the faults associated with deep-seated salt domes through this area does not exhibit a consistent regional alignment, as the faults are localized over each dome. The general fault strike is usually parallel to the long axis of the deep-seated dome with which it is associated.

Faulting over deep-seated salt domes can usually be related to derivative gravity minimums which are expressions of the salt uplifts causing the faulting. The primary faults generally strike parallel to the long axis of the derivative gravity minimum, and faults on the outer margin of a graben structure are usually downthrown towards the long axis of the minimum. Generally, the relative intensity of the derivative gravity minimum becomes greater as the complexity of the faulting becomes greater.

On the complexly faulted structures in this area, the outer faults of a graben system are considered to be the primary faults as they were usually the first faults initiated and they predominate with depth.

Fault dips over deep-seated domes in the NE. portion of the Mississippi salt basin average approximately 45° in the Upper Cretaceous and 60° in the Lower Cretaceous.

An increase in throw with depth is exhibited by faults over deep-seated domes at a rate determined principally by the rate of differential uplifting which the salt exhibited during deposition of the sediments through which the faults cut. The increase in throw with depth is principally a result of lengthening of stratigraphic section in the downthrown block relative to the same section in the upthrown block. This lengthening of section is caused by thickening of downthrown beds and by preserved wedges below unconformities in the downthrown black which are absent in the upthrown block.

As the unconformable contact between the Upper and Lower Cretaceous is the only horizon at which a large increase in throw on faults is evident, it appears that this unconformity is the only one of significant hiatus between Wilcox to basalt Hosston time.

The crest of structures at Lower Cretaceous horizons through this area are commonly located near one side of a graben system. The faults on this side, termed "axial faults," generally bisect the anticlinal crest so that closure is present on both their upthrown and downthrown sides. Lower Cretaceous production is most commonly found along the structural crest on both sides of the axial faults.

Faults with opposing dip on the opposite side of the graben, termed "flank faults," are farther removed from the structural crest and exhibit closure only on the upthrown side. Flank faults provide potential traps if upthrown reservoir beds remain against impervious strata in the downthrown segment during growth of the fault.

Lateral changes in the throw of faults takes place more rapidly on progressively older horizons. The lateral termination of a primary fault off the flanks of a deep-seated salt dome appears to take place on all horizons approximately the same distance from the apex of the dome.--Auth,

3-1441. Gavrish, V.K. ON THE FORMATION OF TERTIARY DOWNWARPS IN THE DNIEPER-DONETS DEPRESSION: Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in translation, v. 125, no. 1-6, p. 216-219, map, chart, March-Apr. 1959, pub. 1960, 9 refs.

Stratigraphic studies in the Dnepr-Donets basin have shown that Tertiary downwarps may be divided into 2 types, regional and local. Regional downwarps are chiefly connected with movement of fault blocks in the crystalline basement. Local downwarps are associated with uplifts involving salt intrusion and are related to their growth.--F. Manheim.

3-1442. Kamb, W. Barclay. THE THERMODYNAMIC THEORY OF NONHYDROSTATICALLY STRESSED SOLIDS: Jour. Geophys. Research, v. 66, no. 1, p. 259-271, 2 figs., Jan. 1961, 20 refs.

Comparison, particularly for application to petrofabric problems, of various current thermodynamic theories of nonhydrostatically stressed solids shows that the theories of Goranson and MacDonald are identical, and that of Verhoogen, suitably generalized, differs only in a way that has no effect on crystal stability as a function of orientation. The theory of Gibbs and Kamb differs in substantial features from the other 3 theories. A close but contradictory relationship between the theoretical results of MacDonald and Kamb is derived. Close examination of the theory of MacDonald reveals that, while superficially the theory appears suited to handling certain mechanical problems, it actually does not deal correctly with these. In fact, the derivation of the theory contains a fundamental error, the correction of which leaves the theory without any content. The theories of Goranson and Verhoogen are contrasted with that of Gibbs, and it is concluded that, among the outstanding theories, only that of Gibbs has any validity.--Auth.

3-1443. Curry, Sharon. THE REORIENTATION OF CALCITE CRYSTALS IN LIMESTONE: Iowa Acad. Sci., Proc., v. 67, p. 246-248, 2 diags., 1960.

Limestone from the Hampton formation [Mississippian] at Ferguson, Iowa, was studied in an effort to determine whether the vertical force of overburden had caused preferential orientation of crystals. Results are insufficient to indicate the extent of recrystallization caused by overburden; there is evidence that there has been horizontal influence also. Petrofabric diagrams are included.--Auth.

3-1444. Beloussov, V.V. DEVELOPMENT OF THE EARTH AND TECTOGENESIS: Jour. Geophys. Research, v. 65, no. 12, p. 4127-4146, Dec. 1960, 59 refs.

Tectogenesis reflects the general tendency in the development of the earth in the direction of its heating by radioactive sources of heat. The accumulated heat is partly removed by means of melting and differentiation of the material of the mantle. Originally melting takes place in the upper layers of the mantle. To this corresponds the first, or granite, stage of tectogenesis, during which there is observed geosynclinal platform development of the earth's crust with its wavelike oscillatory movements. In this process the crust is filled with acidic (granitic) material.

Later a deeper layer of the mantle is subjected to melting, whence overheated basalt ascends to the surface. In the basalt stage tectonic activization is observed, and finally the granite crust is destroyed and oceanization occurs.

Thus elevations and depressions of the earth's crust developed in the process of its wavelike oscillatory movements, on the one hand, and the formation of sea deeps of the mediterranean type (i.e., located on oceanic crust) and oceans, on the other hand, present genetically different processes. They are subjected to different influences and must be studied by different methods. The basic difference between them is that movements of the first type are compensated by the accumulation of sediments and by erosion, whereas those of the second type are not.

All the processes described proceed irregularly, both in time and in space.

Irregularity in time is expressed in the fact that melting does not go on over the whole layer simultaneously, but occurs only in separate foci and only gradually, in the process of their migration, does melting come to cover the entire layer. The activity of separate deep faults, so influential in the melting process and in the vertical circulation of the material of the mantle, is also different at different times. With the irregularity of the removal of heat is connected a complex periodicity or, it might be better to say, an alternation of tectogenesis, which we understand best for the 'granite' stage of development.

Irregularity in space is expressed in the fact that different parts of the earth's surface proceed from one stage of development to another at different times. Regions that are at different stages of development may lie close together on the surface of the earth. This increases the complexity and the variety of the structure of the earth's crust, but it also presents an opportunity to review the history of the development of the crust by means of a comparative study of its different regions.--Auth. concl.

3-1445. Gilreath, J.A. INTERPRETATION OF DIPMETER SURVEYS IN MISSISSIPPI: Gulf Coast Assoc. Geol. Soc., Trans., v. 10, p. 267-275, 15 figs. 1960.

The study of patterns of closely spaced dip computations throughout the length of continuous dipmeter surveys is producing greatly increased geological information in Mississippi wells. Structural dip (or regional dip if no structure is present) is the basic dip shown by the dipmeter. Superimposed on the basic dip are the dips resulting from faults, unconformities, and local depositional features. These are generally greater than structural dips and in random directions.

Faults are most often shown by the increasing dip in the drag zone as the borehole approaches the fault plane from the downthrown side. Complex faulting over shallow ridges or domes may be distinguished by the change in dips between faulted blocks. Buried bars are detected in wells drilled on the steep slopes by the decreasing dips exhibited by the successive younger beds deposited above them. Other changes in dip enable the location of unconformities, most of these being reasonably easy to recognize, since they appear at the same general position in the geological column. Cross-bedding shows up as erratic dips in sands.

It is emphasized that detailed geological interpretations of the dipmeter survey require numerous closely spaced computations studied in relation to the well log.--Auth.

3-1446. Karpov, P.A. **THE QUESTION OF THE AGE OF THE CASPIAN DEPRESSION: Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in translation, v. 125, no. 1-6, p. 252-254, map, 2 tables, March-Apr. 1959, pub. 1960, 9 refs.**

Seismic, borehole, stratigraphic, paleontologic, electric log, and other data have shed light on the history of the Caspian depression. It is suggested that the depression formed first during Devonian time by faulting of the basement. A buried terrace which was discovered by seismic methods is younger than recorded Frasnian deposits. Apparently the boundaries of the Caspian depression in post-Devonian time moved from W. to E. and from N. to S. The depression forms a syneclise or sag in the Russian platform, whose amplitude and depth have been reduced during the course of geologic time.--F. Manheim.

3-1447. Krylov, N.A., and others. **THE GEOLOGICAL DEVELOPMENT OF CISCAUCASIA AND THE SOUTHERN BORDER OF THE RUSSIAN PLATFORM: Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in translation, v. 125, no. 1-6, p. 302-305, map, March-Apr. 1959, pub. 1960, 9 refs.**

Borehole data has confirmed the presence of an epi-Hercynian Cis-Caucasian platform in the southern European part of the U.S.S.R. The folded basement of this platform is younger than that in the pre-Paleozoic Russian platform. The boundary between these 2 platforms is marked by elongated fracture zones.--F. Manheim.

3-1448. Nagibina, M.S. **TECTONIC SYSTEM OF NORTH MANCHURIA: Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in translation, v. 125, no. 1-6, p. 282-284, map, March-Apr. 1959, pub. 1960, 5 refs.**

New stratigraphic and tectonic data make it possible to include N. Manchuria in the Hercynian folded region, located between the ancient Siberian and Chinese-Korean platforms. The Hercynian folded structures of Manchuria were modified by folding movements of late Mesozoic age, which characterize a new postgeosynclinal stage of development of this area.--F. Manheim.

4. STRATIGRAPHY AND HISTORICAL GEOLOGY

See also: Areal and Regional Geology 3-1405, 3-1407, 3-1408, 3-1409, 3-1411; Paleontology 3-1477, 3-1484, 3-1487, 3-1521, 3-1528, 3-1537, 3-1538; Igneous and Metamorphic Petrology 3-1640; Sedimentary Petrology 3-1666, 3-1670; Fuels 3-1721.

3-1449. Smith, L.N. **THE POWER AUGER AS A GEOLOGIC TOOL IN THE COASTAL PLAIN OF SOUTH CAROLINA: South Carolina, State Devel. Board, Div. Geology, Geol. Notes, v. 5, no. 1, p. 7-14, illus., log, Jan.-Feb. 1961.**

The Division of Geology, South Carolina State Development Board, uses a power auger drill to enable geologists to penetrate surficial cover and obtain fresh samples of Coastal Plain formations to depths of 100 ft. The drill allows the tracing and sampling of units that are exposed only poorly at widely separated localities. Geologists operate the drill and are able to obtain a good picture of the units penetrated by combining information gained from cuttings brought up the hole, from material that sticks to the rods, and from the varying speed of penetration and feel of the drill. Reasonably good samples for chemical analyses or studies of fossil content can be obtained by taking care to clean the drill rods carefully between holes and by sampling only relatively thick homogeneous units or relatively undisturbed material that is plastic and tough enough to stick tightly to the auger flights.

Lithologic logs are prepared for each hole drilled and are distributed to geologists particularly interested in the area. Samples are preserved for study by interested geologists.

In addition to stratigraphic information the drill is used to obtain information on clay, sand, gravel, and limestone deposits and to explore foundation and shallow ground-water conditions at proposed industrial sites.--H.S. Johnson, Jr.

3-1450. Goldich, Samuel S., and others. **THE PRECAMBRIAN GEOLOGY AND GEOCHRONOLOGY OF MINNESOTA: Minnesota Geol. Survey, Bull. 41, 193 p., 37 figs. incl. illus., maps, chart, secs., diags., graphs, 5 pls. (in pocket), 32 tables, 1961, approx. 225 refs.**

Radioactivity dating of a large number of igneous and metamorphic rocks by the K-Ar and the Rb-Sr methods is the basis for revision of the classification of the Precambrian rocks of Minnesota. The major divisions of the 3-fold classification are made at time boundaries of 2.5 and 1.7 billion years (b.y.), corresponding to the time of 2 major orogenies, the Algoman and the Penokean, respectively.

The eras are referred to as early, middle, and late Precambrian in preference to the older terminology of earlier, medial, and later Precambrian. The division between the early and middle Precambrian is placed at the time of the Algoman rather than of the older Laurentian orogeny. The division between the middle and late Precambrian is made on the basis of the Penokean orogeny which resulted in a mountain chain that extended from central Minnesota through Wisconsin into Michigan. The Penokean Mountains formerly were assigned erroneously to late Keweenawan time.

The early Precambrian rocks are divided into the Ontarian and the Timiskamian systems. The Ontarian rocks include the Keewatin group of Minnesota and the Coutchiching metasediments which underlie the Keewatin greenstones in Ontario. Some of the gneisses in the Giants Range and the Vermilion granite regions of Minnesota probably were derived by metamorphism of ancient sediments that were deposited prior to the great outpouring of basalt flows assigned to the Ely greenstone of the Keewatin group.

The Laurentian orogeny, although not closely dated, occurred 2.6 billion or more years ago. Folding was accompanied by intrusion of numerous dikes and plutons of tonalitic to granodioritic composition, the largest of which is the Saganaga granite mass on the Minnesota-Ontario boundary. The Ontarian rocks and the Laurentian intrusives are overlain unconformably by the Knife Lake group which is correlated with the Seine of Ontario. These metasediments are assigned to the Timiskamian. The sedimentary cycle was ended by the Algoman orogeny or mountain building.

The Giants Range and the Vermilion batholiths, better called granitic complexes, were formed during the Algoman orogeny. Radioactivity ages for these rocks range from 2.6 to 2.5 b.y. Similar ages were found for the Morton gneiss in the Minnesota River valley. Postkinematic granite plutons, emplaced in the folded Coutchiching metasediments in the Rainy Lake area, Ontario, were mapped by Lawson as Algoman. They are dated at 2.4 b.y. Postkinematic granites in the Minnesota River valley, notably the Sacred Heart granite, give a similar age.

The unconformity at the base of the middle Precambrian Animikie group of the Mesabi district represents a hiatus of several hundred million years. The Animikie formations, the Pokegama quartzite, the Biwabik Fe-formation, and the Virginia argillite were deposited on a relatively stable craton of the early Precambrian granitic rocks. The strata were tilted and warped in the Penokean and subsequent folding but were not highly deformed. To the S., however, the Fe formations and related sediments in the Cuyuna district and the Thomson formation in E.-central Minnesota were tightly folded. Farther S., the McGrath gneiss, dated at 1.7 b.y., is a deeper-seated synkinematic phase of the Penokean orogeny. The St. Cloud Red granite and similar intrusives in Wisconsin and in Michigan, dated at 1.65 b.y., are postkinematic and were intruded following the main period of Penokean folding. Tonalites and granodiorite in the St. Cloud area, dated at 1.8 b.y., may represent an early phase of the Penokean cycle.

Similar relationships are found in the Minnesota River valley where the Montevideo granite gneiss was intruded or folded at approximately 1.8 b.y. This event was followed by the intrusion of a system of basaltic dikes and then by emplacement of a small granite pluton, dated at 1.7 b.y.

The late Precambrian rocks include the Puckwunge formation, the North Shore volcanic group, the late Keweenawan Fond du Lac and Hinckley sandstones, the Duluth complex, and similar intrusive rocks of the North Shore region. A hiatus of several hundred million years is represented in the unconformity at the base of the Puckwunge formation in the Duluth area. The Duluth complex, formed by a number of successive intrusions, was emplaced at approximately 1.1 b.y. In the southwestern part of the state, the Sioux formation of late Precambrian age was folded at about 1.2 b.y.

Ages determined by the K-Ar and by the Rb-Sr methods generally are in good agreement; however, the apparent age obtained by either method may reflect metamorphism subsequent to the original crystallization. The study of the possible loss or gain of parent and daughter nuclides in the minerals and also in the whole rock under diverse geologic conditions is an important area for future investigations.

The geologic names formerly used in Minnesota and in the Lake Superior region have been retained. It is recognized that some of these terms no longer possess their original usefulness; nevertheless, the rejection of the old terms, as well as the introduction of new names, is inadvisable for the present.

The major structural disturbances recorded in the Precambrian rocks of Minnesota and adjacent areas can be correlated tentatively with orogenic cycles in other parts of the world. It is not likely that the world-wide occurrence of radioactivity ages in the ranges: 2.6-2.5 b.y.; 1.8-1.6 b.y.; and 1.1-0.9 b.y. is due to chance. The geosynclinal accumulation of sediments and the mountain building that follows cannot be explained through any agency or force acting entirely within the crust of the earth. Deeper-seated or subcrustal phenomena are involved, and with such hypotheses the case for world-wide orogenies is improved. Equally improved are the prospects that eventually a world-wide time scale for the Precambrian rocks will be evolved.--Auth.

3-1451. Rezanov, I. A. ON THE RIPHAEAN DEPOSITS OF THE OKHOTSK MASSIF: Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in translation, v. 125, no. 1-6, p. 261-262, March-Apr. 1959, pub. 1960.

The most complete section of the Riphean (Eocambrian-Precambrian) yet found has been identified in the Okhotsk massif. The age of the beds was interpreted from algal assemblages in limestone, in particular Conophyton cylindricus. The sequence begins with basal conglomerates resting on the Archean basement, overlain successively by quartzites, siltstones and slates, irregular limestones, siltstones and quartzites, and finally green-gray slates. The Riphean is overlain unconformably by Permian beds and total thickness is about 2,500 m. It is concluded that with the exception of short depressions in late Permian and late Triassic, the massif has been steadily uplifted throughout Paleozoic time.--F. Manheim.

3-1452. Martin, Gene B. A PRELIMINARY INVESTIGATION OF THE UPPER ORDOVICIAN BRYOZOA OF NORTHWESTERN ALABAMA: Gulf Coast Assoc. Geol. Soc., Trans., v. 10, p. 201-205, map, sec., 1960, 27 refs.

An attempt is made to clarify the subdivision of the upper Ordovician strata in northwestern Alabama by the use of Bryozoa and associated fauna. The upper Ordovician limestone exposed in northwestern Alabama (and extending into the northeastern Mississippi subsurface) contains abundant fossils, mainly Bryozoa. These may be used to subdivide this section and to correlate the subdivisions with named units recognized in Tennessee.

The upper part of the "Chickamauga" limestone, a catch-all term, may be divided into the Leipers and Fernvale formations on the basis of diagnostic bryozoan species. The Leipers formation is recognized by the diagnostic species Monticulipora molesta Nicholson and the absence of Richmond species. The Fernvale formation is distinguished by the presence of 6 species that are restricted to that formation out of 24 species identified. The writer recommends that the use of the name "Chickamauga" be avoided in favor of the more specific Leipers and Fernvale formations.

The geographic area of study has been restricted to Limestone County, Alabama, which lies within a section of the Black Warrior basin.

Measured sections of 6 outcrops are presented as a columnar section. A description of the Fernvale and Leipers formations of northwestern Alabama is given with a list of Bryozoa species identified at each collecting locality.--Auth.

3-1453. Ivanovsky, A. B. THE STRATIGRAPHIC POSITION OF THE LOWER LUDLOVIAN SUBSERIES IN THE WESTERN PART OF THE SIBERIAN PLATFORM: Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in translation, v. 125, no. 1-6, p. 246-247, March-Apr. 1959, pub. 1960, 2 refs.

Studies of stromatoporoid, tetracoral, and ostracod fauna have been made on Silurian carbonate rocks in the western part of the Siberian platform. It is concluded that the sections investigated should properly be considered upper Wenlockian rather than lower Ludlovian.--F. Manheim.

3-1454. Dow, Verne E. SOME NOTES ON THE OCCURRENCE OF A COAL SEAM IN THE CEDAR VALLEY FORMATION OF JOHNSON COUNTY, IOWA: Iowa Acad. Sci., Proc., v. 67, p. 253-259, 1960, 11 refs.

Samples of carbonaceous material from several exposures of the Cedar Valley formation [Devonian], have been studied in order to establish a basis for calling the material a coal. Examination has shown that the material is a "cannel" coal, and it is believed to be one of the earliest known coals in North America.--Auth.

3-1455. Lipina, O. A., and others. THE KIZEL HORIZON OF THE SOUTHWEST PART OF THE BIRSK SADDLE: Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in translation, v. 125, no. 1-6, p. 306-307, sec., March-Apr. 1959, pub. 1960, ref.

A brief stratigraphic-paleontologic description is given of the Upper Devonian Kizel horizon of the eastern part of the Russian platform. The horizon consists mainly of algal-foraminiferal limestones and varies in thickness from 50 to 250 m. The horizon is usually traceable both in core samples and by its electric log characteristics.--F. Manheim.

3-1456. Lyashenko, A.I., and S.I. Novozhilova. THE AGE AND SUBDIVISION OF THE UPPER DEVONIAN SHUGUROVO FORMATION IN THE VOLGA-URAL REGION: Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in translation, v. 125, no. 1-6, p. 248-249, March-Apr. 1959, pub. 1960, 5 refs.

The upper clay carbonate unit of the Shugurovo formation in the Trans-Volga region should be referred to the Sargaevo horizon, and the middle unit of the Shugurovo formation should be called the Kikino horizon. The term "Shugurovo formation" may be used to designate the bituminous deposits that occur in several stratigraphic horizons in the lower Frasnian subseries.--F. Manheim.

3-1457. Grachevsky, M. M. FEATURES OF THE STRUCTURE AND FORMATION OF THE KAMA-KINEL DEPRESSION IN THE KUIBYSHEV TRANS-VOLGA REGION AND TATARIA: Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in translation, v. 125, no. 1-6, p. 296-298, March-Apr. 1959, pub. 1960, 16 refs.

The Kama-Kinel depression is a narrow, approximately 1,000 km. long belt of thick terrestrial rocks in the Volga-Ural oil-bearing region. The stratigraphy is similar to the edge of the Permian basin in North America, and it is suggested that deposits were formed in the absence of tectonic activity by marginal filling of a topographic depression, apparently with the assistance of a barrier reef along the outer edge of the growing shelf.--F. Manheim.

3-1458. Wagner, James K. STRATIGRAPHIC STUDIES OF THE GILMORE CITY FORMATION AT RUTLAND, IOWA: Iowa Acad. Sci., Proc., v. 67, p. 249-252, sec., 1960, 5 refs.

An interesting relationship between the beds of limestone and dolomite in a quarry and at outcrops along the Des Moines River near Rutland, Iowa, is described. In the quarry a composite of 11 ft. of limestone-dolomite-limestone is exposed, whereas at an outcrop along the river 300 ft. NE. the dolomite is absent and 12 ft. of limestone is exposed. These beds of limestone and dolomite have been referred to the St. Louis formation unconformably overlying Gilmore City limestone [Mississippian]. The author proposes that the dolomite represents an area of late diagenetic alteration within the Gilmore City formation.--Auth.

3-1459. Wier, Charles E. STRATIGRAPHIC RELATIONS OF THE MEROM SANDSTONE NEAR MEROM, INDIANA: Indiana Acad. Sci., Proc., v. 69, p. 217-223, map, sec., 1959, pub. 1960, 6 refs.

Data is presented and discussed bearing on the stratigraphic position of the late Pennsylvanian Merom sandstone in its type region. It consists of an upper medium- to coarse-grained sandstone and a lower conglomerate. Fossils include brachiopods and crinoid stems. Regional correlation is best achieved by reliance on associated key beds of which the underlying Livingston limestone is an example.--M. Russell.

3-1460. Kulikov, M.V. STRATIGRAPHIC SYSTEM OF THE TRANSBAIKAL PERMIAN DEPOSITS: Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in translation, v. 125, no. 1-6, p. 276-278, table, March-Apr. 1959, pub. 1960, 8 refs.

A brief summary of stratigraphic-paleontological data available on the Permian of Transbaikal. A table is included correlating the main marine deposits within Transbaikal as a whole, and regional correlations are suggested.--F. Manheim.

3-1461. Barkhatov, B.P., and others. NEW DATA ON THE PERMIAN DEPOSITS OF NORTHERN PAMIR: Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in translation, v. 125, no. 1-6, p. 290-292, map, March-Apr. 1959, pub. 1960, 5 refs.

Stratigraphic-paleontologic data on the Permian of Pamir indicate that the flora and fauna are quite typical of the Caucasian biogeographic district. The "violet" formation must be revised upward from middle Lower Permian, perhaps to as late as Cretaceous. Discovery of Lower Permian fauna in the northern metamorphic zone indicates the unity of the whole northern zone until Upper Permian time. --F. Manheim.

3-1462. Letavin, A.I., and N.A. Krylov. ON THE TRANSITION COMPLEX OF CISCAUCASIA: Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in translation, v. 125, no. 1-6, p. 255-257, 2 maps, March-Apr. 1959, pub. 1960, 9 refs.

The stratigraphy, age and regional distribution of the red transition complex of Cis-Caucasia has been studied. This series forms a transition from the rocks of the Cis-Caucasian platform sediments to the Paleozoic basement. The complex consists chiefly of coarse clastics and is considered to be of Permian and Triassic age. It is concluded that an epi-Hercynian platform is present in Cis-Caucasia, and that the boundary between the Hercynian and the Mesozoic in this area was characterized by general uplift. Associated with the uplift were grabenlike processes which produced the red sedimentary complexes.--F. Manheim.

3-1463. Andrews, Donald I. THE LOUANN SALT AND ITS RELATIONSHIP TO GULF COAST SALT DOMES: Gulf Coast Assoc. Geol. Soc., Trans., v. 10, p. 215-240, 9 figs. incl. maps, secs., graph, 2 tables, 1960, 66 refs.

A review was made of the literature and other available data pertaining to the Louann or "Mother" salt of the Gulf Coastal basin. Numerous facts and theories relating to various aspects of the salt are presented, and the most widely accepted ideas are discussed in terms of recent developments.

The Louann salt is part of an evaporite sequence found in the Gulf Coastal basin of the United States. It is best studied at its updip bedded limits where the sequence unconformably overlies Paleozoics and is in turn overlain, perhaps unconformably, by the Norphlet and Smackover formations of Upper Jurassic age. The age of the salt itself cannot be definitely proven. It is known to be older than Upper Jurassic, but believed to be no older than Upper Permian. The original average bedded salt thickness is estimated to be approximately 5,000 ft.

Chemical experiments indicate that there is an excess of Louann salt in relation to the amount of underlying Werner anhydrite. Therefore, it is believed that prepared brines of highly concentrated sodium chloride content may have been introduced into the Louann basin from an outside source, 2 possible sources being the Permian basin of W. Texas and the Sabinas basin of NE. Mexico. The Louann-Werner depositional basin or basins could have had several different forms, but is believed to have been a single, vast, widespread basin. Conditions comparable to Branson's "modified bar theory" probably existed during evaporite deposition. The present day Gulf of Mexico, a large gravity maximum, appears to be closely related to the original salt depositional basin.

A more or less continuous bed of Louann salt is believed to underlie the entire Gulf Coastal basin. The Louann is probably the source or "Mother" bed for all the salt found in the piercement domes of the 4 subbasins, which now exist within the Gulf Coast basin. Although the salt found in the downdip Texas-Louisiana coastal basin domes theoretically could be younger than Louann, a study of the available evidence points to this salt also being Louann. The absence of salt domes in the "barren" or "void" band, which runs W.-E. from E.-central Texas through central Louisiana and into southern Mississippi, may be due to shifting areas of sediment overburden, and/or the possibility that salt was thinly deposited in this area.--Auth.

3-1464. Charygin, M.M., and I.V. Bezborodova. ON THE HISTORY OF THE GEOLOGICAL DEVELOPMENT OF THE PSHEKHA-KUBAN INTERFLUVE IN THE NORTHERN CAUCASUS IN LATE JURASSIC TIME: Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in translation, v. 125, no. 1-6, p. 265-268, 3 maps, March-Apr. 1959, pub. 1960, 5 refs.

The Pshekha-Kuban interfluve in the northern Caucasus may be separated into 3 lithostratigraphic complexes, corresponding to Callovian, Oxfordian, and Kimmeridgian-Tithonian age. Data from core drilling operations in the area have permitted outlining of the thickness and facies distribution of these complexes in Late Jurassic time.--F. Manheim.

3-1465. Arkhangelsky, A.I. THE STRATIGRAPHY OF THE CARBONACEOUS DEPOSITS OF THE EASTERN SLOPE OF THE LITTLE KHINGAN RANGE: Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in translation, v. 125, no. 1-6, p. 226-227, March-Apr. 1959, pub. 1960, 5 refs.

The stratigraphy, paleobotany, and lithology of the Little Khingan carbonaceous deposits are summarized. The floral and lithologic evidence indicates that the age of the Bira formation ranges from Jurassic to Lower Cretaceous. The lower carbonaceous sediments are correlated with the carbonaceous rocks of the Butefsk formation of the upper Amur coal region. Regional and local correlations are presented in some detail.--F. Manheim.

3-1466. McLean, James D., Jr. STRATIGRAPHY OF THE PARRIS ISLAND AREA, SOUTH CAROLINA: McLean Paleont. Lab., Rept. no. 4, 70 p., secs., tables, 1960, 33 refs.

Studies of several wells from the Parris Island area in South Carolina reveal the necessity for definition of stratigraphic boundaries ascribed to the area. Microfossils and a few macrofossils form a good basis for several stratigraphic boundaries and also establish the presence locally of Miocene, Oligocene and definite Paleocene stratal units.--Auth.

3-1467. Stuckey, Charles W., Jr., A CORRELATION OF THE GULF COAST JACKSON: Gulf Coast Assoc. Geol. Soc., Trans., v. 10, p. 285-298, 5 figs. incl. 2 maps, 1960, 40 refs.

All the names of Jackson [Eocene] formations, members, and other subdivisions described in the area from the Rio Grande River of Texas through Louisiana and Mississippi to eastern Alabama with part of Arkansas are given with a history of the nomenclature. A correlation chart is also given. Paleostratigraphic zones relating to the surface and subsurface are established. These zones from youngest to oldest are: *Discorbis texana* zone, upper Jackson, shallow- and deep-water facies; *Textularia hockleyensis* zone, middle Jackson, shallow- and deep-water facies; *Textularia dibollensis* zone, lower Jackson; *Camerina* and *Operculina* zone, basal Jackson. A diagrammatic section illustrating the foraminiferal ecology is presented. Electric logs giving the subsurface section are included.--Auth.

3-1468. Morozova, V.G., and Yu. A. Sudarikov. UPPER EOCENE KERESTINSK FORMATION OF THE SALO-ERGENI UPLAND AND ITS STRATIGRAPHIC SIGNIFICANCE: Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in translation, v. 125, no. 1-6, p. 223-

225, illus., March-Apr. 1959, pub. 1960, 8 refs.

Detailed stratigraphic description of an important Paleogene type section in the Crimea-Caucasus region. The section consists mainly of glauconitic sands, marls, and clays, and contains an abundant foraminiferal fauna. Three new species are described.--F. Manheim.

3-1469. Kleiner, Yu. M. NEW DATA ON THE PLIOCENE OF THE LITTORAL PART OF THE MANGYSHLAK STEPPE: Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in translation, v. 125, no. 1-6, p. 231-233, fig., March-Apr. 1959, pub. 1960, 2 refs.

Pliocene limestones and other sediments from the Mangyshlak steppe are discussed in the light of new stratigraphic and paleontological data. It is concluded that the maximum Akchagyl transgression in the area coincided with the present shore of the Caspian sea. A few conglomerate traces in the S. part of the area are remnants of a pre-Akchagyl uplift.--F. Manheim.

3-1470. Terasmae, Jaan, and Owen L. Hughes. A PALYNOLOGICAL AND GEOLOGICAL STUDY OF PLEISTOCENE DEPOSITS IN THE JAMES BAY LOWLANDS, ONTARIO: Canada, Geol. Survey, Bull. 62, 15 p., map, 5 diags., 1960, 22 refs.

Stratigraphic studies of Pleistocene deposits in the James Bay lowlands have shown that the sequence begins with glacial deposits overlying bedrock. This part of the sequence consists of 2 members, the lower drift and the middle drift. These glacial deposits are overlain by layers of peat, silt and clay, here named the Missinaibi beds, which in turn are overlain by glacial deposits of the main Wisconsin glaciation. Marine clay, commonly fossiliferous, overlies the upper glacial drift and is overlain by postglacial fluvial, lacustrine, and organic deposits.

Palynological studies have been made of both the Missinaibi beds and the postglacial deposits. Vegetation during the deposition of the Missinaibi beds was similar to that present now in the James Bay lowlands. On basis of palynological evidence an interstadial rank is proposed for the Missinaibi beds, and radiocarbon dating suggests an age of 55,000 to 64,000 years.--Auth.

3-1471. Devyatova, E.I. MARINE INTERGLACIAL DEPOSITS IN THE ONEGA RIVER BASIN: Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in translation, v. 125, no. 1-6, p. 220-222, 2 profiles, March-Apr. 1959, pub. 1960, 3 refs.

Studies of the marine interglacial deposits in the Onega River basin revealed molluscan and diatom fauna of arctic and temperate character. The pollen and spore assemblages of the area could be correlated with standard sections of the European plain and showed mixed forests being replaced by taiga with first light and later dark conifers. The Valdai glaciation was the latest to traverse the area.--F. Manheim.

3-1472. Tikhvinsky, I.N. THE NATURE OF THE PERMIAN LANDSCAPE IN SOUTHERN TATARIA AND NEIGHBORING REGIONS: Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in translation, v. 125, no. 1-6, p. 250-251, map, March-Apr. 1959, pub. 1960, 3 refs.

Structural drilling in the middle Volga region has provided considerable data on the continental interruption which occurred in this area in middle Permian time. A close relationship between Permian land forms and present-day tectonic patterns in the investigated area was found. It is concluded that the structural pattern of the region in middle Permian time was similar to the present pattern.--F. Manheim.

3-1473. Nikonov, A.A. A RECONSTRUCTION OF THE NEOTECTONIC CONDITIONS AND THE PALEOGEOGRAPHY OF THE LATE GLACIAL PERIOD WITH THE AID OF THE EPEIROGENIC SPECTRUM IN THE CONTINENTAL PART OF THE KOLA PENINSULA: Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in translation, v. 125, no. 1-6, p. 258-260, fig., March-Apr. 1959, pub. 1960, 6 refs.

Detailed studies of terrace levels of late glacial basins on the Kola peninsula have permitted reconstruction of the epeirogenic spectrum in the area. In addition to lithostratigraphic correlation, analyses of the diatom fauna and spore and pollen studies have assisted in dating the levels. Assuming that the maximum Portlandia transgression occurred about 10,500 years ago, it is estimated that the western parts of the Lotta depression have been emerging at an average rate of 1.4-1.5 cm. per year, and the eastern parts at about .9-1.0 cm. per year.--F. Manheim.

3-1474. Tilton, George R., and others. 1000-MILLION-YEAR-OLD MINERALS FROM THE EASTERN UNITED STATES AND CANADA: Jour. Geophys. Research, v. 65, no. 12, p. 4173-4179, map, 5 tables, Dec. 1960, 19 refs.

Minerals with ages of about 1,000 m. y. have been found in Ontario, along the Appalachians from New York to North Carolina, and also beneath the sedimentary covering in Michigan, Ohio, and West Virginia. Measurements have been made on muscovite, biotite, microcline, uraninite, and zircon. This occurrence is interpreted as indicating the extent of igneous intrusion and metamorphism accompanying a major orogeny about 1,000 million years ago.--Auth.

3-1475. Vistelius, Andrew B. THE PROBLEM OF THE ORIGIN OF THE RED BEDS OF THE CHELEKEN PENINSULA. AN EXPERIMENT ON THE USE OF ABSOLUTE AGE OF CLASTIC MINERALS FOR THE SOLUTION OF PROBLEMS OF LITHOLOGY AND PALEOGEOGRAPHY: Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in translation, v. 125, no. 1-6, p. 293-295, 2 graphs, table, March-Apr. 1959, pub. 1960, 5 refs.

First attempts in the Soviet Union were made to determine the absolute age of micaceous minerals and clay in the clay fraction of clay-rock and sands by the Ar method. Micaceous minerals were first separated by sieving, followed by mica separation on a vibrating surface and purification by an electromagnetic separator. Biotite was similarly separated from volcanic ash.

The age of the micaceous minerals and clays ranged from 82 to 250 million years and showed rather consistent results. On the basis of the data gained, it is concluded that the age of the mica in the Cheleken Cretaceous deposits is the same as that of the Krasnovodsk granitoids. A somewhat younger age for the Cheleken carboniferous clays is explained partly by loss of Ar during specimen preparation and partly by authigenic glauconite formation. The age of mica from Cheleken sandstone beds is not older than Upper Cretaceous, which indicates that these sands have been derived from a district where Cretaceous intrusives or their weathering products have been eroded.--F. Manheim.

5. PALEONTOLOGY

See also: Areal and Regional Geology 3-1406, 3-1407; Geomorphology 3-1418; Stratigraphy 3-1452, 3-1467, 3-1468, 3-1470, 3-1471; Sedimentary Petrology 3-1667, 3-1668.

3-1476. Plumb, Robert K. EVIDENCE OF LIFE BEYOND EARTH REPORTED FOUND IN METEORITE: New York Times, v. 110, no. 37,673, p. 12, col. 4-6, March 17, 1961.

Analysis of a fragment of the Orgueil, France, 1864, meteorite shows the presence of cycloparaffins or steranes closely akin to chemical compounds in the living processes of plants and animals on earth, and as such is the first physical evidence of life forms beyond the earth. No age determinations have been made of the Orgueil meteorite. The findings by Bartholomew Nagy, Douglas J. Hennessy, and Warren G. Meinschein were reported to the New York Academy of Sciences.--M. Russell.

3-1477. Laughbaum, L. Ronald. A PALEOECOLOGIC STUDY OF THE UPPER DENTON FORMATION, TARRANT, DENTON, AND COOKE COUNTIES, TEXAS: Jour. Paleontology, v. 34, no. 6, p. 1183-1197, 3 figs., table, Nov. 1960, 32 refs.

The Denton formation (Lower Cretaceous) was measured at 7 localities in Tarrant, Denton, and Cooke counties. Lithologic samples and fossil collections were taken from the oyster biostrome at the top of the formation.

The fauna collected from the biostrome includes 19 genera and 24 species of Foraminifera, 1 species of coral, 19 genera of bryozoans, 8 genera and 14 species of pelecypods, 1 species of gastropod, 9 genera and 17 species of ostracods, 1 species of echinoid, and 3 species of holothurian sclerites.

Based on living representatives of families, the biostrome is inferred to have been formed in waters of normal salinity except in the most northern localities, and at very shallow depths throughout the entire area although slightly deeper at the southern localities. Turbidity was somewhat less than during deposition of other parts of the Denton formation, and semi-tropical to tropical temperatures are indicated. Reduction in turbidity apparently allowed the biostrome to begin growth, and increase in turbidity probably ended growth.

One of the most important aspects of the biostrome is the change in fauna from a dominance of Gryphaea washitaensis Hill in the southern localities to Ostrea (Arctostrea) carinata Lamarck and then Ostrea (Lopha) quadriplicata Shumard in the most northern localities.--Auth.

3-1478. Korde, K.B. PROBLEMATIC FOSSILS FROM THE CAMBRIAN DEPOSITS OF THE SOUTHEAST OF THE SIBERIAN PLATFORM: Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in translation, v. 125, no. 1-6, p. 358-360, fig., March-Apr. 1959, pub. 1960.

A number of problematic forms, not hitherto described in the literature, were found in Cambrian limestones near the Lena river. In spite of certain features similar to sponges, the absence of spicules in their skeleton and their mode of growth suggest that they most resemble hydrozoan coelenterates. Illustration and description of the forms are given. --F. Manheim.

3-1479. Butler, Phillip E. MORPHOLOGIC CLASSIFICATION OF SPONGE SPICULES, WITH DESCRIPTIONS OF SILICEOUS SPICULES FROM THE LOWER ORDOVICIAN BELLEFONTE DOLOMITE IN CENTRAL PENNSYLVANIA: Jour. Paleontology, v. 35, no. 1, p. 191-200, 7 figs., pl., Jan. 1961, 20 refs.

Siliceous sponge spicules from the Bellefonte dolomite near Union Furnace, central Pennsylvania, are described and illustrated. The new species, Hyalostelia clinopentactinoides, is described. Hyalostelia Zittel and the genotype, Hyalostelia smithii (Young and Young), from the Carboniferous of Scotland, are briefly discussed. A morphologic classification for siliceous spicules, based with some modifications upon review of previous work, is presented together with illustrations of major spicule types.--Auth.

3-1480. Finks, Robert M. LATE PALEOZOIC SPONGE FAUNAS OF THE TEXAS REGION. THE SILICEOUS SPONGES: Am. Mus. Nat. History, Bull., v. 120, art. 1, 160 p., 77 figs., 50 pls., 1960, 112 refs.

A taxonomic and faunal study of the siliceous sponges of the later Pennsylvanian and Permian of the midcontinent region, including the standard Permian section of W. Texas. It is based primarily on large collections at the U.S. National Museum and at the American Museum of Natural History, as well as on the type specimens of all previously described species from the same area. A general introductory discussion reviews the composition and historical development of the entire sponge faunas of the area and geologic systems studied, including the calcareous sponges which are not treated taxonomically here.

The sponge faunas discussed here are the most diverse known in the geologic record between the Devonian and the Jurassic. The siliceous sponges dealt with in the present paper constitute about half of the total sponge fauna in terms of numbers of species. Forty-three named species are described, plus 9 new but unnamed forms. Three new superfamilies, 7 new families, 17 new genera, and 32 new species have been established. The anatomy of Heliospongia has been reinterpreted on the basis of excellently preserved material, and it has been placed among the monactinellid demosponges. The evolution of the hexactinellids has been reconsidered, and it is concluded that in the early Paleozoic 2 main lines diverged from a common stock, one of which gave rise to many later dictyonines.

In the descriptions of individual species, particular attention has been paid to individual variation, to ontogenetic development, and to evidences for ecological relationships exhibited by the specimens. The large size of the collections and the generally excellent preservation of the material have made such aspects of the study feasible. Only those species represented by nearly complete specimens have been named, for isolated spicules or small fragments of sponges provide insufficient morphological information.

Faunal facies can be recognized, which are related to bathymetry inferred from physical stratigraphic evidence. These are similar in distribution to present communities of sponges. The shoal-water faunas were dominated by calcareous sponges and the deeper-water faunas by siliceous sponges. Evidence is presented that the marginal areas of the stagnant-basin facies of the Texas Permian were not completely anaerobic, despite the high organic content of the sediment, because the sponges and some of the associated faunal elements were autochthonous to the sediments. The late Paleozoic shoal-water sponge fauna in the Texas region shows a continuous and partly endemic development. A significant external faunal element appears at the beginning of the Leonardian. Stratigraphic zonation of the sponges tends to confirm that established on the basis of the other faunal elements.

The taxonomic composition of the Permian sponge faunas, in relation to earlier and later faunas, indicates that the Paleozoic-Mesozoic boundary is marked by the extinction of several long-ranging Paleozoic families that flourished until the end of the Permian. The dominant groups of Mesozoic sponges, on the other hand, were already present in the late Paleozoic and seem not to have been affected by the post-Permian withdrawal of epicontinental seas.--Auth.

3-1481. Berry, William B.N. EARLY LUDLOW GRAPTOLITES FROM THE ASHLAND AREA, MAINE: Jour. Paleontology, v. 34, no. 6, p. 1158-1163, 2 figs., Nov. 1960, 10 refs.

An assemblage of graptolites characteristic of the early Ludlow zone [Silurian] of *Monograptus nilssoni* is recorded from the vicinity of Ashland, Aroostook County, Maine. The zone of *M. nilssoni* may be correlated with the latter part of the Niagaran. Most of the forms in the assemblage are monograptides of the *dubius-vulgaris-tumescens* groups. One new species, *M. forbesi*, and 2 new varieties, *M. tumescens* var. *contus* and *M. vulgaris* var. *ashlandensis*, are described.--Auth.

3-1482. Sysoev, V.A. THE SYSTEMATICS OF THE HYOLITHIDS: Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in translation, v. 125, no. 1-6, p. 355-357, 2 figs, March-Apr. 1959, pub. 1960, 9 refs.

Extensive literature review and study of hyolithids from the Cambrian of the Siberian platform have given rise to a number of conclusions on the taxonomic importance and systematics of the superorder Hyolithoidea. A terminology for morphological features, methods of measurement, and a classification of the hyolithids are presented.--F. Manheim.

3-1483. Ivanovsky, A.B. THE QUESTION OF THE SYSTEMATIC POSITION OF THE ORDOVICIAN AND SILURIAN ZAPHRENTOID CORALS: Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in translation, v. 125, no. 1-6, p. 364-366, 5 illus., March-Apr. 1959, pub. 1960, 5 refs.

Literature studies and investigations of Siberian rugose corals of Ordovician and Silurian age have led to a separation of a new family, the Protozaphrentidae, fam. nov. The evolution of this family is considered to be marked by stereoplasmic thickening of the septa and the gradual acquisition by the tabulae of a more or less convex shape. The solitary form of growth has been preserved throughout.--F. Manheim.

3-1484. Sando, William J. CORALS FROM WELL CORES OF MADISON GROUP, WILLISTON BASIN: U.S. Geol. Survey, Bull. 1071-F, p. 157-190, 2 figs., 8 pls. (3 in pocket), 1960, 27 refs.

Mississippian corals from 3 wells in the Madison group in northeastern Montana are divided into 3 groups for facies analysis: nondissepimented solitary corals, dissepimented solitary corals, and colonial corals. Lateral changes in abundance, diversification, and vertical limits of the coral fauna seem to be directly related to changes in lithic facies within the Madison group. Northward impoverishment of the fauna of the Lodgepole limestone seems to be correlated with increase in clay content and decrease in grain size of the limestone toward the center of a basin characterized by poor circulation of the sea water. The fauna of the overlying Mission Canyon limestone is more uniformly distributed, suggesting a widespread, generally well-aerated environment. The distribution of corals in the Charles formation appears to be related to northward increase in evaporites, which indicate extreme restriction of the late Early Mississippian sea in this region.

The corals of the Madison group hold little promise as horizon markers for detailed local correlation within the Williston basin because of strong facies control and the long stratigraphic range of common genera. They offer greater potential for regional correlation because of the wide distribution of distinctive associations of genera and species in rocks of Early Mississippian age.

The 24 species that are described and illustrated are distributed among the following genera: *Amplexocarinia*, *Amplexus*, *Cyathaxonia*, *Homalophyllites*, *Menophyllum?*, *Rotiphyllum*, *Rylstonia*, *Zaphrentites*, *Caninia*, *Caninophyllum*, *Enygmophyllum*, *Vesiculophyllum*, *Zaphriphyllum*, *Aulopora*, *Cladochonus*, *Cleistopora*, *Lithostrotion*, and *Syringopora*.--Auth.

3-1485. Sando, William J. MORPHOLOGY AND ONTOGENY OF *ANKHELASMA*, A NEW MISSISSIPPIAN CORAL GENUS: Jour. Paleontology, v. 35, no. 1, p. 65-81, 13 figs., 2 pls., Jan. 1961, 15 refs.

The new genus *Ankhelasma* is proposed for hapsiphyllid corals found in the Brazer dolomite of NE. Utah and the Hannan limestone of NW. Montana. The known occurrences are in beds considered to be of early Late Mississippian (Meramec) age. *Ankhelasma*, which resembles *Homalophyllites* in external features of the corallum, is distinguished by the conspicuous development of 5 septal plates and the absence of tabulae.

A large collection of well-preserved silicified specimens of *Ankhelasma typicum*, n. sp., provided an opportunity for detailed study of ontogenetic trends in a population. Changes in 6 basic morphologic characters related to form and size of the corallum are traced through 11 growth stages distinguished on the number of major septa. The data suggest that curvature of the corallum and flattening of its convex side are due to genetic factors associated with maintaining negatively geotropic growth and stability after toppling from an erect, apically attached position. Progressive obliteration of attachment scars and reduction of apical diameter are attributed to corrosion or abrasion after the corallum became free.

Hypothetical growth curves are derived by plotting 2 linear characters related to the size of the corallum against time scales based on progressively decreasing growth rates. A logarithmically decreasing growth rate produces the S-shaped curve that characterizes the growth of most simple organisms.--Auth.

3-1486. Fay, Robert O. PTYCHOBLASTUS, A NEW MISSISSIPPIAN BLASTOID FROM MISSOURI: Jour. Paleontology, v. 34, no. 6, p. 1198-1201, fig, Nov. 1960, 5 refs.

A new genus, Ptychoblastus, is recorded from the Warsaw limestone formation, at Keyes Summit, St. Louis County, Missouri. The type species Ptychoblastus pustulosus Fay, n. sp., has one hydrospire fold on each side of an ambulacrum and a hydrospire plate and associated pores along the margins of the deltoids. The latter feature is a new structure reported to be present in blastoids.--Auth.

3-1487. Ross, June R.P. Phillips. LARGER CRYPTOSTOME BRYOZOA OF THE ORDOVICIAN AND SILURIAN, ANTICOSTI ISLAND, CANADA - PART I: Jour. Paleontology, v. 34, no. 6, p. 1057-1076, map, diag., 4 pls., 7 tables, Nov. 1960, 21 refs.

The larger cryptostome Bryozoa from the late Ordovician and early and middle Silurian strata of Anticosti Island when studied by thin section techniques consist of 9 species, 2 of which are new, Ptilodictya denticulata and Pachydictya n. sp. Seven of the species had previously been given a total of 16 names. Ptilodictya denticulata is restricted to the English Head formation (upper Ordovician) and Phaenopora superba first appears in the Becscie formation (lower Silurian) and extends into the overlying Gun River formation (lower Silurian). The other cryptostome bryozoan species range from the late Ordovician into the early and middle Silurian strata except for 2 species of Stictopora which are found only in the upper Ordovician. Comparison of the bryozoan faunas and other Anticosti Island faunal elements with those in other areas from late Ordovician and early Silurian strata suggests the English Head, Vaureal, and Ellis Bay formations are equivalent in age to the Richmond group, Ohio, and it does not support the placement of these Anticosti beds into a "Gamachian series" of post-Richmond but pre-Silurian age.

Based on skeletal microstructures observed in type material and additional material, the 5 species of Ptilodictya and one species of Stictoporella, S. excellens, described in this paper may be conveniently assigned to the informal taxonomic category of the escharoporid group.--Auth.

3-1488. Burckle, Lloyd H. SOME MISSISSIPPIAN FENESTRATE BRYOZOA FROM CENTRAL UTAH: Jour. Paleontology, v. 34, no. 6, p. 1077-1098, map, 5 pls., Nov. 1960, 26 refs.

Fenestrate bryozoans from the Mississippian of central Utah are illustrated and described. Two families, the Fenestellidae and the Acanthocladiidae, are included in this study. The Fenestellidae studied include 6 genera, 1 subgenus, 23 species, 13 of which are new, and 1 new subspecies. The Acanthocladiidae include 2 genera and 3 new species.

The genus Fenestella includes 6 new species - F. hamithensis, F. rarinodosella, F. tooelensis, F. acarinata, F. utahensis, and F. dissepinodaria; 1 new subspecies, F. serratula subsp. humbugensis; and 5 previously described forms, F. regallis Ulrich, F. parallela Hall, F. serratula Ulrich, F. rarinodosa Condra & Elias and F. tenax Ulrich. The subgenus Minilya includes 2 new forms, F. (Minilya) incipiens and F. (Minilya) crockfordae. The genus Archimedes is represented by A. macfarlani Condra & Elias and A. owenanus Hall. Fenestralia sancti-ludovici Prout is present in the collection along with the new species F. trifurcata. Hemitrypa is represented by the new species H. reticulata. Polypora includes 2 new species, P. micronodosa and P. stansburyensis, and 2 previously described species, P. cestriensis Ulrich and P. debilis Elias. Thamniscus includes 1 new species, T. raribifurcatus. Among the Acanthocladiidae, the genus Ptylopora includes 2 new species, P. condrai and P. eliasi, and the genus Septopora is represented by 1 new species, S. ulrichi.--Auth.

3-1489. Sadlick, Walter. NEW NAME FOR SPIRIFER OCCIDENTALIS (GIRTY) AND ITS GEOLOGIC HISTORY: Jour. Paleontology, v. 34, no. 6, p. 1210-1214, table, Nov. 1960, 21 refs.

Spirifer occidentalis (Girty, 1927) Dunbar & Condra, 1932, is a homonym of Spirifer occidentalis Kindle, 1908, and is renamed Spirifer occiduus. The earliest known representatives of this species occur in the environs of Millard County, Utah, and this area could be the evolutionary center of the species. Spirifer occiduus, of early Pennsylvanian age, probably evolved from a new undescribed species similar to Spirifer pellaensis Weller, 1914, of late Mississippian age.--Auth.

3-1490. Sarycheva, T.G., and A.N. Sokolskaya. THE CLASSIFICATION OF THE PSEUDOPUNCTATE BRACHIOPODS: Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in translation, v. 125, no. 1-6, p. 348-350, chart, March-Apr. 1959, pub. 1960, 8 refs.

A brief discussion of previous classifications and the history of the development of pseudopunctate brachiopods is presented. It is felt that the pseudopunctate brachiopods are not a homogeneous group, but are clearly divided into 2 related but independent orders, Strophomenida and Productida. A common feature of most of these forms is absence of a brachial apparatus and a functional pedicle in the adult forms of the productids and the majority of the strophomenids. An important difference between the 2 is the complete absence of spines in the strophomenids and their constant occurrence on the productids.--F. Manheim.

3-1491. Maxwell, W.G.H. LOWER CARBONIFEROUS BRACHIOPOD FAUNAS FROM OLD CANNINDAH, QUEENSLAND: Jour. Paleontology, v. 35, no. 1, p. 82-103, 2 figs., 2 pls., table, Jan. 1961, 61 refs.

Brachiopods constitute a major element in the lower Carboniferous reef and pre-reef faunas from Old Cannindah. They occur in 6 of the 8 known assemblages which range from late Tournaisian to late Viséan in age. Five new species and varieties are described, viz., Daviesiella cannindahensis, Prospira burnettensis, Prospira typa var. tellebangensis, Kitakamithyris globosa, and Martinia neoproductoides, while 6 existing species and varieties are redescribed, viz.: Rugosochonetes kennedyensis var. magnus Maxwell, Rhipidomella australis (McCoy), Prospira typa Maxwell, Ectochoristites wattsi Campbell, Brachythyris cf. davidis (Dun), and Kitakamithyris uniplicata (Campbell). Type specimens of Prospira typa and P. prima are refigured.--Auth.

3-1492. Campbell, K.S.W. THE BRACHIOPOD GENERA INGELARELLA AND NOTOSPIRIFER IN THE PERMIAN OF QUEENSLAND: Jour. Paleontology, v. 34, no. 6, p. 1106-1123, 3 figs., 6 pls., table, Nov. 1960, 21 refs.

The genera Ingelarella and Notospirifer are widespread throughout the Permian of eastern Australia. Previously described species now assigned to these genera are examined. Eight new species are described from the Springsure shelf and the northern end of the Bowen basin: I. plica, I. plana, I. ingelarensis, I. magna, I. mantuanensis, I. pelicanensis, I. havilensis, and N. minutus. All species are found to have a very restricted stratigraphic range. Alternative correlations to those in current use are suggested.--Auth.

3-1493. Montoya, Maria del Carmen Perrilliat. MOLUSCOS DEL MIOCENO DE LA CUENCA SALINA DEL ISTMO DE TEHUANTEPEC, MEXICO [Miocene Molluscs of the Salt Basin of the Isthmus of Tehuantepec, Mexico]: Mexico, Universidad Nacional, Instituto de Geologia, Paleontologia Mexicana, no. 8, 38 p., 2 maps, 4 pls., table, 1960, 59 refs.; text in Spanish.

This work describes and illustrates 6 species of pelecypods (2 new: Anadara (Anadara) istmica and Anadara (Anadara) woodringi) and 17 species of gastropods from the Miocene Agueguexquite formation of the Isthmus of Tehuantepec.--Auth., translated by L.M. Dane.

3-1494. Zimmermann, Richard, and Ellis L. Yochelson. THE CAMBRIAN GASTROPOD CLOUDIA BUTTSI IN MISSOURI: Jour. Paleontology, v. 35, no. 1, p. 229-230, 3 illus., Jan. 1961, 3 refs.

The first occurrence of Cloudia buttsi outside of Alabama is reported from SE. Missouri. The single specimen, an incomplete sandstone steinkern collected from beds probably assignable to the undifferentiated Late Cambrian Derby and Doe Run dolomites, is the only fossil found in an area of about 50 sq. mi. --I.M. Johnston.

3-1495. Glen, William. PLIOCENE FRESH-WATER GASTROPODS FROM SAN MATEO COUNTY, CALIFORNIA: Jour. Paleontology, v. 34, no. 6, p. 1207-1209, illus., Nov. 1960, 12 refs.

Parapholyx durhami and Fluminicola sanmateoensis, both new species, are described from a new locality in the fresh-water upper Pliocene? Santa Clara formation in N.-central San Mateo County, California.--Auth.

3-1496. Yochelson, Ellis L. NOTES ON THE CLASS CONICONCHIA: Jour. Paleontology, v. 35, no. 1, p. 162-167, Jan. 1961, 22 refs.

Hyolithes has been variously classified by different authors, most placing it somewhere within the Mollusca. Coniconchia Liashenko, 1957, was proposed as a class containing 2 super orders, Hyolithoidea and Tentaculoidea; the class was questionably referred to the Mollusca. There seems to be no reason to question placement of Coniconchia as mollusks and there is no theoretical objection to basing a class or any other major category on fossils rather than living specimens. It is suggested that each of the superorders eventually should be raised to class rank.--Auth.

3-1497. Yochelson, Ellis L. THE OPERCULUM AND MODE OF LIFE OF HYOLITHES: Jour. Paleontology, v. 35, no. 1, p. 152-161, fig., 2 pls., Jan. 1961, 22 refs.

A reexamination of Hyolithes carinatus Matthew from the Middle Cambrian Burgess shale [of British Columbia] has shown that the features considered by C.D. Walcott to be supports for the fins of pteropods actually appear to be outgrowths of the operculum. If the dorsal point of the operculum was hinged at the dorsal point of the aperture a push of the body outward would have swung it upward. The supports may then have served to prop up the operculum and keep it open. Because of the supports and other features of shell morphology, Hyolithes is interpreted as a virtually sessile, benthonic organism, the longest side of the shell being ventral.--Auth.

3-1498. Kummel, Bernhard. MIDDLE TRIASSIC NAUTILOIDS FROM SINAI, EGYPT, AND ISRAEL: Harvard Univ., Mus. Comp. Zoology, Bull., v. 123, no. 7, p. 285-302, map, 4 pls., Dec. 1960, 36 refs.

Triassic formations and faunas from the southern part of Tethys in the Middle East are incompletely known. This describes a small fauna from Arai-el-Naga, Sinai, and the Makhtesh (Wadi) Ramon, Israel. A review of the known few areas of Triassic formations indicate in their stratigraphy and facies development approximation to the southern shores of Tethys. The systematic descriptions include the following new designations: Mojsvaroceras n. sp. indet., and Indonautilus awadi n. sp. The largest number of specimens are of the genus Germanonautilus.--M. Russell.

3-1499. Sellers, D.H.A., and W.M. Furnish. MISSISSIPPIAN AMMONOIDS FROM NORTHWESTERN CANADA: Jour. Paleontology, v. 34. no. 6, p. 1124-1128, map, 2 figs., pl., table, Nov. 1960, 15 refs.

Upper Mississippian ammonoids are recorded and described from 2 localities. Well preserved specimens representing Goniatites crenistria Phillips, an index fossil known in various parts of the world, come from the Peel River in N.-central Yukon Territory. A single individual described as a new species, Prolecanites warreni Sellers & Furnish, was secured from a well core in the Liard River area of northern British Columbia.--Auth.

3-1500. Cobban, William A., and George Gryc. AMMONITES FROM THE SEABEE FORMATION (CRETACEOUS) OF NORTHERN ALASKA: Jour. Paleontology, v. 35, no. 1, p. 176-190, 2 figs., 2 pls., 5 tables, Jan. 1961, 44 refs.

The Seabee formation, 400-1,800 ft. thick, contains 2 ammonite faunas that are assigned to the Turonian stage of the Upper Cretaceous. These ammonites reveal a mixing of elements from the Atlantic and Pacific faunal realms. The species of Scaphites and Watinoceras are Atlantic types whereas the species of Otoscaphites, Borissiakoceras, and Proplacenticereas seem to have a Pacific source. A connection of the Western Interior seaway with the Pacific Ocean via the Arctic Ocean along northern Alaska seems likely. New species described are Scaphites subdelicatulus, Otoscaphites seabeenis, Borissiakoceras inconstans, and B. ashurkoffae.--Auth.

3-1501. Haas, Otto H. A PLACENTICERAS WITH FEATHER STRUCTURE: Jour. Paleontology, v. 35, no. 1, p. 230, illus., Jan. 1961, 2 refs.

Feather structure is clearly exhibited by a specimen of Placenticeras whitfieldi from South Dakota.--I.M. Johnston.

3-1502. Leutze, Willard P. ARTHROPODS FROM THE SYRACUSE FORMATION, SILURIAN OF NEW YORK: Jour. Paleontology, v. 35, no. 1, p. 49-64, 2 figs., 2 pls., 2 tables, Jan. 1961, 18 refs.

Paleoecological interpretation of the Salina (Upper Silurian) section in New York state, based on lithologies and faunas, indicates a shallow aquatic environment with highly variable salinity. The Syracuse formation, which includes the major evaporite beds of the region, contains undescribed ostracodes, a trilobite (Calymene sp.), 2 species of Ceratiocaris (Ceratiocaris sp. and C. nolli n. sp.), and eurypterids assignable to 5 genera. Eurypterus remipes flintstonensis Swartz, Erieopterus sp., and specifically undeterminable Pterygotus fragments occur in the upper Syracuse. Pterygotus fragments have also been found near the bottom of the formation. Waeringopterus cumberlandicus apfeli n. gen., n. subsp., is restricted to the lowest member of the Syracuse formation. A single fragment of Carcinosoma has been found in the Camarotoechia zone, near the middle of the formation.--Auth.

3-1503. Rasetti, Franco. DRESBACHIAN AND FRANCONIAN TRILOBITES OF THE CONOCOCHEAGUE AND FREDERICK LIMESTONES OF THE CENTRAL APPALACHIANS: Jour. Paleontology, v. 35, no. 1, p. 104-124, fig., 5 pls., Jan. 1961, 23 refs.

This paper includes: 1) Additions to the Franconian Elvinia zone fauna from the Conococheague formation [Cambrian] in Virginia; 2) Description of a faunule of the Dresbachian Crepicephalus zone from the same formation and area; 3) Description of a faunule of the Dunderbergia zone, the first recognized in eastern North America, from the basal Frederick limestone [Cambrian] of Maryland. The occurrence of trilobites of the Dunderbergia zone in exotic boulders in the Lower Ordovician of Quebec is also discussed. Systematic descriptions include 3 new trilobite genera: Bathyholcus (type, B. gaspensis, n. sp.); Glyptometopsis (type, G. tumida, n. sp.); and Taenicephalites (type, T. macrops, n. sp.). Other described new species are: Bathyholcus sulcatus, Blountia virginica, Dunderbergia simplex, Glaphyraspis ovata, Glyptometopsis? marginata, Komaspidella laevis, K. lata, Llanoaspis convexifrons, Meteoraspis mutica, Quebecaspis marylandica, Q. conifrons.--Auth.

3-1504. Lochman-Balk, Christina, and Chung-hung Hu. UPPER CAMBRIAN FAUNAS FROM THE NORTHWEST WIND RIVER MOUNTAINS, WYOMING. PART II: Jour. Paleontology, v. 35, no. 1, p. 125-146, 5 pls., Jan. 1961, 14 refs.

The Cedaria zone faunules from the 2 measured sections near Green River Lakes in the northwestern Wind River Mountains, Wyoming, contain 27 genera and at least 54 species of trilobites. The species of 5 families and a number of unplaced forms are described in this paper. The Asaphiscidae are represented by Blountia and Vernaculina flexiosa, n. gen., n. sp.; the Coosellidae by Coosella vagrans, n. sp., and 2 species of Syspacheilus including S. praecedens, n. sp., and S. praecedens elongatus, n. var.; the Marjumidae by 3 genera including Shickshockia? occidentalis, n. sp.; the Menomoniidae by 2 genera including Densonella praesemele, n. sp., and D. praesemele transitans, n. var.; and the Tricrepicephalidae with 3 species of Meteoraspis, including M. intermedia, n. sp. The new material has furnished much information about M. globosa (Miller), M. boulderensis DeLand, and also Syspacheilus dunoirensis (Miller). Densonella semele and Modocia centralis range through 95 to 125 ft. of section and appear as stable species indigenous to the Utah-Wyoming area. Syspacheilus and Densonella show significant evolutionary developments through their vertical range.--Auth.

3-1505. Churkin, Michael, Jr. SILURIAN TRILOBITES FROM THE KLAMATH MOUNTAINS, CALIFORNIA: Jour. Paleontology, v. 35, no. 1, p. 168-175, 2 pls., Jan. 1961, 16 refs.

The Gazelle formation in the Klamath Mountains is a eugeosynclinal suite of rocks from which well-preserved Silurian brachiopods and trilobites were discovered. A faunule containing the trilobites Leonaspis (Acanthalomina) minuta (Barrande), Dicranopeltis cf. C. decipiens (Weller), Trochurus sp. indet., Scutellum sp. indet., Proetus sp. indet., Cheirurus cf. C. insignis Beyrich, Encrinurus (Cromus) beaumonti (Barrande) is described. Encrinurus and Proetus are the only genera previously reported from the western states. Leptaena rhomboidalis Wilckens?, Atrypa reticularis Linnaeus var. orbicularis Sowerby?, Atrypella scheii (Holtedahl)?, and Gypidula sp. are brachiopods from this faunule.

Gazelle trilobites are very closely related to the classical Bohemian fauna and some are conspecific. In addition the brachiopod assemblage more closely resembles the Alaskan and Asian faunas than those of the Great Basin and eastern North America.--Auth.

3-1506. Jux, Ulrich. MONTECARIS LEHMANNI, A NEW CRUSTACEAN FROM THE RHENISH DEVONIAN AND THE PROBLEM OF ITS SYSTEMATIC POSITION: Jour. Paleontology, v. 34, no. 6, p. 1129-1152, 11 figs., 2 pls., 2 tables, Nov. 1960, 37 refs.

A new phyllocarid, Montecaris lehmanni, has been found in the Devonian platy limestones of the Bergisch Gladbach syncline of the Rhenish massif of Western Germany. This paper is presented in order to describe fully the fossil and its occurrence. After a discussion of the general profile of the area and the paleogeographic conditions in the middle and upper Devonian times, it is concluded that the upper Plattenkalk resting above the lydite series belongs to the Frasnian group of strata because of diabase volcanism attendant upon its formation. The distribution of Upper Devonian rocks in this syncline is thus considerably enlarged.

Anatomic studies of the perfectly preserved specimen of Montecaris lehmanni Jux, n. sp., and comparison of it with related fossils and recent forms, reveal that the dorsal shield of phyllocarids correspond very closely to that of the Apodidae. Further, the development of the free abdominal region of Montecaris lehmanni is more related to that of the Apodidae than to the Nebaliacea, which is presently considered to be the group most related to fossil phyllocarids. The structure of the mandibles, found partly in fossil forms in their original locations, is much the same as that found in Apus and Lepidurus. The ventral appendages of Nahecaris and especially Vachonisia also show a clear correspondence to the Apodidae and with this evidence there can be no doubt that the fossil phyllocarids are an order of the Branchiopoda similar to Notostraca.--Auth.

3-1507. Brady, L. F. A NEW SPECIES OF PALAEOHELCURA GILMORE FROM THE PERMIAN OF NORTHERN ARIZONA: Jour. Paleontology, v. 35, no. 1, p. 201-202, pl., Jan. 1961, 4 refs.

A new species of Palaeohelcura, from the Coconino sandstone (Permian) of northern Arizona, is described as differing from Palaeohelcura tridactyla Gilmore in the pattern of foot impressions.--Auth.

3-1508. Zangerl, Rainer, and Robert E. Sloan. A NEW SPECIMEN OF DESMATOCHELYS LOWI WILLISTON, A PRIMITIVE CHELONIID SEA TURTLE FROM THE CRETACEOUS OF SOUTH DAKOTA: Chicago, Nat. History Mus., Fieldiana: Geology, v. 14, no. 2, p. 7-40, 23 figs., 2 pls., 1960, 15 refs.

A second specimen of Desmatochelys lowi Williston, herein described, complements the type specimen to a notable extent. Since the present material is uncrushed, a number of peculiar aspects of the type specimen, such as the dermochelyid or protostegid appearance of the humerus, could be explained as due to deformation.

The skeleton of Desmatochelys exhibits a number of features that are seen in toxochelyid, protostegid and dermochelyid turtles, but in its over-all morphology it is unmistakably though primitively cheloniid.

An analysis of the locomotor apparatus of Desmatochelys indicates primitive cheloniid affinities; the peculiarities of the skull such as the nasal bones and the primary palate are primitive features among chelonoid turtles and are to be expected among early Cheloniidae.--Auth. summ.

3-1509. Lundelius, Ernest L., Jr., and S. St. J. Warne. MOSASAUR REMAINS FROM THE UPPER CRETACEOUS OF WESTERN AUSTRALIA: Jour. Paleontology, v. 34, no. 6, p. 1215-1217, map, Nov. 1960, 14 refs.

Mosasaur remains, collected on the Australian continent for the first time, are recorded from the Molecap greensand in Western Australia near Gingin. The material, consisting of a left ulna and a paddle bone, appears closest to Platecarpus from the Niobrara formation of Kansas, which is now considered Santonian in age. Mosasaurs will probably prove useful in interregional correlations but only after careful description and reclassification.--I. M. Johnston.

3-1510. Etheridge, Richard. ADDITIONAL NOTES ON THE LIZARDS OF THE CRAGIN QUARRY FAUNA: Michigan Acad. Sci., Arts & Letters, Papers, v. 45, p. 113-117, fig., 1960, 2 refs.

A brief review of the occurrence of Holbrookia texana, Eumeces obsoletus, Phrynosoma modestum, Crotaphytus collaris, Cnemidophorus sexlineatus, and Phrynosoma cornutum in the Cragin Quarry fauna of the Kingsdown formation, deposited in Meade County, SW. Kansas, during the Sangamon interglacial interval of the Pleistocene. Sexual dimorphism is reported for lower jaws of Crotaphytus collaris. A brief consideration of the paleoecologic significance of the fauna is included.--J. A. Dorr, Jr.

3-1511. Hough, Jean Ringier. REVIEW OF OLIGOCENE DIDELPHID MARSUPIALS: Jour. Paleontology, v. 35, no. 1, p. 218-228, 2 figs., Jan. 1961, 9 refs.

Small marsupials very similar to the present day South American opossums are common in Oligocene deposits. Locally they may be very numerous. When the extremely small size is considered, their relative abundance in Oligocene collections is surprising. Most of the specimens, however, are lower jaws, usually fragmentary. There are some upper dentitions and a few skulls. One skeleton has been described from the Florissant beds. The small size and fragmentary nature of the specimens make classification extremely difficult. The current view, as reflected by the taxonomy is that the North American didelphids were an extremely conservative group, hardly differing generically from the Eocene to the Miocene and with virtually no speciation in the Oligocene.

McGrew in his description of Nanodelphys suggested that this idea, based on the conservatism of the dentition might be illusory. There is a rather wide diversity of habit among the living South American genera which is reflected in the foot structure rather than the dentition. A study of lower Oligocene specimens referred to Peratherium indicates rather clearly that McGrew's view is correct and that there were at least 3 genera of didelphids in the Oligocene and probably 6 or more species. It is still impossible to do more than guess at the diversity of habit because the foot structure is still unknown in most genera. Differences in the skull and upper dentition and the mandible, however, parallel those of certain of the South American genera and would seem to indicate that there was a radiation of North American opossums in the Oligocene similar in kind and extent to that which has occurred in Recent times in South America.--From introd.

Variation in modern and Oligocene didelphids is discussed; also the following genera: Herpetotherium Cope, Peratherium Aymard, Didelphidectes, Nanodelphys.

3-1512. Simons, Elwyn L., and Donald E. Russell. NOTES ON THE CRANIAL ANATOMY OF NECROLEMUR: Breviora, no. 127, 14 p., 3 figs., Dec. 1960, 12 refs.

The large number of well-preserved skulls of Necrolemur antiquus of the late Eocene Quercy phosphorites of S.-central France allow for much more detailed study of cranial anatomy in this primate than is possible for most early members of the order. However, views as to the taxonomic position of this primate, and of the allied genera Microchoerus, Nannopithex, and Psudoloris show considerable variance.

Little dental variability is evidenced in specimens of Necrolemur antiquus examined, however, a number of diffences in position and size of basicranial foramina were observed, which are in line with mutability of cranial foramina (in individuals of the same species) reported by other authors. Also, in Necrolemur the probability remains that known specimens differ considerably in age (from early Bartonian to late Ludian, at least), but locality data are inadequate for precise age determinations.

To date, the most detailed studies of the cranium of Necrolemur have been by Stehlin and by Hürzeler. Stehlin's thorough and excellent description can scarcely be improved on. The implications of some of his early observations seem to have been neglected in later literature. In some rather significant points, recent examination of more and different skulls permits comments supplementary to his work. Description of the cranial characters covers the auditory region, the basicranium, and the orbit.--From introd.

3-1513. Melhorn, Wilton N. THE PARRISH AND GLASFORD MASTODONS: Indiana Acad. Sci., Proc., v. 69, p. 189-192, table, 1959, pub. 1960, 5 refs.

The Parrish and Glasford, Indiana, specimens of Mammut americanus were examined. The Parrish mastodon, Fulton County, was an adult somewhat larger than average; the remains are excellently preserved. The Glasford, Miami County, mastodon is in an advanced stage of decomposition and may not be worth further salvaging. Both were found in Pleistocene moraine deposits, but the Parrish mastodon was in saturated peat whereas the Glasford was in well-drained sand.--M. Russell.

3-1514. Shotwell, J. Arnold. LATE TERTIARY BIOGEOGRAPHY OF HORSES IN THE NORTHERN GREAT BASIN: Jour. Paleontology, v. 35, no. 1, p. 203-217, 8 maps, 2 charts, Jan. 1961, 19 refs.

The late appearance of the single toed horse, Pliohippus, in the northern Great Basin provides an opportunity for study of its environmental requirements in contrast to those of the 3-toed horse, Hipparion, which occupied the region earlier and contemporaneously. Many characteristics of vegetational change in the northern Great Basin of the late Tertiary coincide with the historical biogeography of these and other horses in this region. This conclusion leads to possible answers to related problems of migration, homotaxis, community change, and morphology in equids.--Auth.

3-1515. Hibbard, Claude W., and Frank J. Hinds. A RADIOCARBON DATE FOR A WOODLAND MUSK OX IN MICHIGAN: Michigan Acad. Sci., Arts & Letters, Papers, v. 45, p. 103-111, map, 2 pls., 1960, 10 refs.

Three vertebrae, found in a marl pit in Kalamazoo County, Michigan, in lacustrine material of post-Cary age, are identified as Symbos cavifrons, considered to have been a woodland or steppe dweller. The radiocarbon date for material from the third cervical vertebra is 13,000± 600 B.P. in C^{14} years. Dating was done by the University of Michigan Memorial-Phoenix Project Laboratory. Other Pleistocene musk-ox finds in Michigan are reviewed. The only other radiocarbon date for Pleistocene vertebrate material from Michigan is from tusk material of Mammut americanus, in which case outer tusk material gave a 7,820± 450 B.P. C^{14} age and inner tusk material from the same specimen gave an age of 7,070± 240 B.P. C^{14} years. Boötherium, described by Gidley in 1908 as another form of musk-ox from Michigan, is considered to be a female of Symbos cavifrons. The authors (contrary to Kitts) consider Euceratherium to belong to the tribe Euceratherini, not the Ovibovini (musk-ox).--J. A. Dorr, Jr.

3-1516. Green, Morton. LATE PLEISTOCENE MAMMALS FROM WESTERN SOUTH DAKOTA: South Dakota Acad. Sci., Proc., v. 39, p. 38-40, 1960, 4 refs.

Western South Dakota Pleistocene fossil vertebrates thus far reported include Megalonyx sp., Mammut americanum, Elephas (Mammuthus) columbi, Elephas (Mammuthus) sp., and Equus sp.

This paper enlarges the list with the following forms: Castor canadensis. Equus (Plesippus) sp., Camelops sp., and Bison bison.--F. V. Steece.

3-1517. Miklukho-Maklai, A. D. ON THE STRATIGRAPHIC IMPORTANCE, SYSTEMATICS, AND PHYLOGENY OF THE STAFFELLA-LIKE FORAMINIFERA: Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in translation, v. 125, no. 1-6, p. 361-363, illus., chart, table, March-Apr. 1959, pub. 1960, 17 refs.

Staffella-like Foraminifera are separated into 2 families, the Ozawainellidae and the Staffellidae. The family Ozawainellidae, as interpreted at present, is divided into 3 subfamilies, Ozawainellinae Thompson et Foster, 1937, Pseudostaffellinae Putrja, 1956, and the Reichelininae M. Maklai, subfam. nov. A discussion and description of the groupings are given. In particular, these forms are of importance as guide fossils in the Carboniferous and Permian systems.--F. Manheim.

3-1518. Ireland, H. Andrew. EMENDATIONS TO UPPER PENNSYLVANIAN ARENACEOUS FORAMINIFERA FROM KANSAS: Jour. Paleontology, v. 34, no. 6, p. 1217-1218, Nov. 1960.

One species and one genus of Upper Pennsylvanian Foraminifera are preoccupied, and the new names Bigenerina perkinsi (=Bigenerina elongata Ireland), and Saccamminis (=Saccamminoides Ireland) are proposed. Other errors in the original text are also corrected.--I. M. Johnston.

3-1519. Butterlin, Jacques, and Federico Bonet. MICROFAUNA DEL EOCENO INFERIOR DE LA PENINSULA DE YUCATAN [Microfauna from the Lower Eocene of the Yucatan Peninsula]: Mexico, Universidad Nacional, Instituto de Geologia, Paleontologia Mexicana, no 7, 18 p., map, 3 pls., 7 tables, 1960, 23 refs.; text in Spanish.

This work comprises the study of a microfauna of Foraminifera, described for the first time, from the lower part of the Chichen-Itza formation in the southwestern part of the Yucatan Peninsula. It describes and discusses in detail the stratigraphic distribution of the following species: Coskinolina elongata Cole, Borelis floridanus Cole, Operculina catenula Cushman and Jarvis, and Discocyclina (Discocyclina) cristensis (Vaughan), assigning a lower Eocene age.--Auth., translated by L. M. Dane.

3-1520. Waller, Harry O. FORAMINIFERAL BIOFACIES OFF THE SOUTH CHINA COAST: Jour. Paleontology, v. 34, no. 6, p. 1164-1182, 14 maps, chart, 2 tables, Nov. 1960, 28 refs.

About 147 bottom samples from the Asiatic shelf, S. of Taiwan Island and in the Gulf of Tonkin were analyzed for their foraminiferal content. It was found that the foraminiferal number, percentage of planktonic Foraminifera, and species number increased with depth. The occurrence of high percentage areas of arenaceous and porcelaneous populations were bimodal, parallel to shore. No unidirectional trends were noted with the hyaline population. Glauconite replacement of Foraminifera was most pronounced in Hainan strait.

Four depth dominant faunas were established: 1) Inner Shelf Fauna (65-150 ft.) Elphidium advenum, E. sagrum, Nonion japonius; 2) Central Shelf Fauna (151-275 ft.) Amphistegina lessonii, Hanzawaia nipponica, Streblus tepidus; 3) Outer Shelf Fauna (276-400 ft.) Biloculinella labiata, Cassidulina neocarinata, Spiroloculina communis; 4) Upper Bathyal Fauna (401-656 ft.) Bolivina spathylata, Uvigerina auberiana, U. schwageri.--Auth.

3-1521. Rexroad, Carl B., and Charles E. Clarke. CONODONTS FROM THE GLEN DEAN FORMATION OF KENTUCKY AND EQUIVALENT FORMATIONS OF VIRGINIA AND WEST VIRGINIA: Jour. Paleontology, v. 34, no. 6, p. 1202-1206, map, table, Nov. 1960, 12 refs.

The conodont fauna of the Glen Dean formation (Chester, Mississippian) is known to be uniform in composition and distribution throughout the Illinois basin. However, virtually no conodont occurrences have been described from a geosynclinal environment, and no study has been made to relate shelf and geosynclinal occurrences. Such a study is the primary purpose of this paper.

Although approximately 1,850 specimens were recovered from the 6 sections sampled, less than one-third of them are generically identifiable, exclusive of fragments of the long ranging genus Hindeodella. Twenty-seven named species distributed among 13 genera, including Hindeodella, are represented. The most abundant species is Cavusgnathus unicornis Youngquist & Miller. The second most common is Neoprioniodus scitulus (Branson & Mehl).

The distribution of species within the area studied is quite uniform, but abundance of the conodonts varies markedly in differing lithologies and with the thickness of the sections involved.

It is suggested that the difference in the faunas of the present study, the Illinois basin Glen Dean, the Gnathodus bilineatus zone of the Barnett formation of Texas, and the Delaware Creek member of the Caney shale is primarily one of geographic province rather than a time disparity. The Illinois basin represents one faunal province, the indicated portions of the Barnett and Caney represent another, and the area of this study shows commingling of the two. There is no evidence of any middle Mississippian elements in the parts of either the Caney or Barnett as mentioned above. Streptognathodus, which may be as old as very uppermost Chester but is commonly considered Pennsylvanian, is present in the upper part of the Sand Branch member of the Caney shale and in beds considered to belong with the Barnett. Accordingly, the Delaware Creek member of the Caney and the Gnathodus bilineatus zone of the Barnett must be considered of Chester age, with the possibility that they may also represent deposition into the Pennsylvanian.--From auth.

3-1522. Ellis, Brooks F., and Angelina R. Messina. CATALOGUE OF OSTRACODA, VOLUME 14: [571] p., illus., New York, American Museum of Natural History, 1960, 28 refs.

The fourteenth volume of the Catalogue of Ostracoda contains 408 units, of which 15 represent genera or subgenera, and 393 represent species or subspecies (varieties). Of the latter group, all but 3 are illustrated. The units that are not illustrated are new names for previously illustrated species. Of the 15 genera or subgenera, 1 represents a new name.

This volume includes the new species described by Reuss and Roemer in their classic works of 1850 and 1838, respectively, as well as those of Pokorný, 1953. In this last work, Pokorný designated lectotypes for 2 of Reuss' species. All the forms included in this volume are post-Paleozoic, ranging in age from Jurassic to Recent.--Auth.

3-1523. Ellis, Brooks F., and Angelina R. Messina. CATALOGUE OF OSTRACODA, VOLUME 15: [509] p., illus., New York, American Museum of Natural History, 1960, 21 refs.

The fifteenth volume of the Catalogue of Ostracoda contains 431 units, of which 26 represent genera or subgenera, and 405 represent species or subspecies (varieties). Of the latter group, all but 5 are illustrated. The units that are not illustrated comprise 3 new names for previously illustrated forms, in addition to 1 species and 1 variety that have apparently never been illustrated.

Fossil forms of all ages have been included in this volume in accordance with the policy adopted in Vol. 11. The distribution of the forms in the present volume is as follows: Paleozoic (Middle Ordovician) 108; post-Paleozoic (Mesozoic and Cenozoic) 323.--Auth.

3-1524. Sohn, I. G. PALEOZOIC SPECIES OF BAIRDIA AND RELATED GENERA: U. S. Geol. Survey, Prof. Paper 330-A, p. 1-105, 15 figs., 6 pls., 1960, 204 refs.

Paleozoic species of the [ostracode] genus Bairdia have been critically examined and revised by use of punched cards. These species are referred to the following genera: Bairdia McCoy, Cryptobairdia n. gen., Rectobairdia n. gen., Bairdiacypris Bradfield, Fabalicypris Cooper, Orthobairdia n. gen., Pustulobairdia n. gen., Ceratobairdia Sohn, Bairdiolites Croneis and Gale, Rishona n. gen., and Bekena Gibson. Other species are referred to Basslerella? Kellett, Camdenidea Swain, Cavellina? Coryell, Haworthina Kellett, and Steusloffina Teichert. The stratigraphic range of Bairdia, as redefined, is restricted to rocks of Middle Devonian to Permian age. It is suggested that the post-Paleozoic species referred to this genus belong to other genera, several of which are listed, and some of which are still undescribed. Homonyms of Paleozoic species are renamed as follows: Bairdia egorovi (B. symmetrica Egorov, 1953), B. elongatella (B. plebia elongata Kirkby, 1859), B. girtyi (B. attenuata Girty), Cryptobairdia contractella (B. hisingeri contracta Jones and Kirkby, 1895), Orthobairdia kirki (B. compressa Geis, 1932), Rectobairdia posneri (Bairdia angulata Posner, 1951).

The following genera are discussed: Silenites Coryell and Booth, Tubulibairdia Swartz, Phanassymetria Roth, Pachydomella Ulrich, Spinobairdia Morris and Hill, and Bairdiocypris Kegel. The new family Rishoniidae is erected for Rishona n. gen. and Samarella Polenova, 1952. Reversocypris Přibyl, 1955, is here tentatively considered a junior subjective synonym of Samarella. A new family to be named by Berdan and Sohn is discussed and illustrated by means of polished sections and radiographs.

A key to the more important genera and nine dichotomous keys to the species in these genera are presented. Some of these species are here considered nomina dubia. Misidentifications that belong to new species, except for Bairdia hassi n. sp., and B. pseudoglennensis n. sp., are not named; they are indicated by letters. Lectotypes for Orthobairdia cestriensis (Ulrich), 1891, Bekena pecki (Morey), 1935, Cryptobairdia recta (Harlton), 1929, Bairdia crassa Harlton, 1929, and Bairdia girtyi Sohn, n. name are described and illustrated. Rishona bassleri n. sp. is described and illustrated.--Auth.

3-1525. Puri, Harbans S. **RECENT OSTRACODA FROM THE WEST COAST OF FLORIDA:** Gulf Coast Assoc. Geol. Soc., Trans., v. 10, p. 107-149, 46 figs., 6 pls., table, 1960, 144 refs.

Recent ostracode fauna from 7 localities (Alligator Harbor, Ochlockonee Bay, Tampa Bay, Crane Key, Bahia Honda, Molasses Reef, and Key Largo dry docks) is described and illustrated. Seventy species, distributed over 37 genera, occur in the bays and the inner neritic zone. Three genera, Megacythere (type species: Megacythere robusta Puri, n. sp.), Neocaudites (type species: Neocaudites nevianii Puri, n. sp.), and Reticulocythereis (type species: Reticulocythereis floridana Puri, n. sp.), and 22 species (Actinocythereis subquadrata Puri, n. sp., Acuticythereis tuberculata Puri, n. sp., Bairdia shulerae Puri, n. sp., Bradleya hornibrooki Puri, n. sp., Bythocypris laeva Puri, n. sp., Caudites angulata Puri, n. sp., Caudites howei Puri, n. sp., Cyprideis floridana Puri, n. sp., Cytheropteron howei Puri, n. sp., Cytherelloidea sarsi Puri, n. sp., Hemicytherura cranekeyensis Puri, n. sp., Hulingsina sulcata Puri, n. sp., Kangarina bradyi Puri, n. sp., Leptocythere cranekeyensis Puri, n. sp., Leptocythere yoni Puri, n. sp., Loxoconcha postdorsoalata Puri, n. sp., Loxoconcha ochlockoneensis Puri, n. sp., Megacythere robusta Puri, n. sp., Neocaudites nevianii Puri, n. sp., Platella Mulleri Puri, n. sp., Puriana floridana Puri, n. sp., Reticulocythereis floridana Puri, n. sp.) are described as new. A new subfamily, Campylocytherinae, is erected to include Campylocythere Edward, Acuticythereis Edwards, Basslerella Howe, Buntonia Howe and Thalmania De Roy.--Auth.

3-1526. Tasch, Paul, and James R. Zimmerman. **FOSSIL AND LIVING CONCHOSTRACAN DISTRIBUTION IN KANSAS-OKLAHOMA ACROSS A 200-MILLION-YEAR TIME GAP:** Science, v. 133, no. 3452, p. 584-586, map, table, Feb. 24, 1961, 3 refs.

Fifty-nine of 493 ponds sampled in the Wellington fossil conchostracan belt contained Cyzicus mexicanus (Claus). Persistent habitat preference and faunal association were also found for 4 orders of insects (Odonata, Ephemeroptera, Neuroptera, and Homoptera). Comparative limnology is detailed. Greater geographic fractionation of Permian conchostracan gene-pools is attributed to a more arid climate indicated by evaporites.--Auth.

3-1527. Baxter, James W. **CALCISPHAERA FROM THE SALEM (MISSISSIPPIAN) LIMESTONE IN SOUTHWESTERN ILLINOIS:** Jour. Paleontology, v. 34, no. 6, p. 1153-1157, pl., Nov. 1960, 14 refs.

Thin sections of the Salem limestone from outcrops in the Mississippi River bluffs in southwestern Illinois contain tiny, calcareous spheres which are prominent elements in certain types of limestone. These microorganisms are referable to the genus Calcisphaera established by Williamson. They vary in size, having diameters of 30 to 165 microns. They occur most abundantly in calcisiltites and calcarenites in which microcrystalline, nonskeletal grains are important rock-forming elements. They also occur in calcilutite.--Auth.

3-1528. Maslov, V.P. **STROMATOLYTES AND FACIES:** Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in translation, v. 125, no. 1-6, p. 278-281, March-Apr. 1959, pub. 1960, 11 refs.

Stromatolites are the only widely dispersed organic formations of the Precambrian, and a number of divergent classifications of these forms are current. It is considered that stromatolites are very shallow-water complexes of lower algae, chiefly of the blue-green type. The optimum conditions for the growth of these forms are an alternating marine-brackish environment, hot climate, and minimal influx of terrestrial detritus. Stromatolites are correlated with the shallows of epicontinental seas associated with platform sediments and had a marked development in Proterozoic, Cambrian, and Ordovician time. They undergo constitutional changes during geologic history and are regarded as valid stratigraphic indicators.--F. Manheim.

3-1529. Johnson, J. Harlan. **JURASSIC ALGAE FROM THE SUBSURFACE OF THE GULF COAST:** Jour. Paleontology, v. 35, no. 1, p. 147-151, 2 pls., 3 tables, Jan. 1961, 9 refs.

Fossil calcareous algae occur abundantly in limestone cores from the subsurface of Alabama, Arkansas, and Texas. They belong to the families Codiaceae and Dasycladaceae of the Chlorophyta (green algae). Described are Marinella lugeoni Pfender, Cayeuxia americana Johnson, n. sp., Bouenia? sp.?, Acicularia jurassica Johnson, n. sp., and Cylindroporella texana Johnson, n. sp.--Auth.

3-1530. Johnson, J. Harlan, and Kenji Konishi. **AN INTERESTING LATE CRETACEOUS CALCAREOUS ALGA FROM GUATEMALA:** Jour. Paleontology, v. 34, no. 6, p. 1099-1105, pl., Nov. 1960, 41 refs.

Pycnoporidium sinuosum, n. sp., is described from the Upper Cretaceous San Cristóbal formation of Guatemala. The species is the first known Late Cretaceous representative of this Late Jurassic-Cretaceous genus. The authors discuss the classification of genera of the Solenoporaceae of the late Mesozoic and suggest the genus Pycnoporidium be excluded from the family. A suggestion is made that the genus be placed among the Siphonocladaceae of the Chlorophyceae. A probably symbiotic alga, "Girvanella cfr. tosaensis Yabe et Toyama," occurs in association with P. sinuosum.--Auth.

3-1531. Tasch, Paul. PALEOECOLOGICAL OBSERVATIONS OF THE WELLINGTON SALT (HUTCHINSON MEMBER): Kansas Acad. Sci., Trans., v. 63, no. 1, p. 24-30, 2 pls., Spring 1960, 2 refs.

The results and interpretations of a careful study of shales interbedded with and trapped in salt of the Permian Hutchinson member of the Wellington salt as exposed in the Carey mine at Hutchinson, Kansas, are presented. Dissolving of the salt from the large blocks left a shally residue in which some evidence of fossil life was found. Diplococcuslike bodies (bacteria) were observed in the salt samples. The conclusion was that these bodies were dead Permian bacteria. A viable culture was obtained. Paleoecological implications indicate that fernlike or similar vegetation must have lived in isolated patches not too distant from the crystallizing body of water. The interbedded shales suggest dessication of surface clay muds occurred after sea invasion. The clay, silt, and fossils are thought to have been brought into the saline basin from a seaside swamp. Bacteria were probably carried in with the decaying vegetation of a neighboring swamp.--J.J. Stephens.

3-1532. Reiser, Ralph, and Paul Tasch. INVESTIGATION OF THE VIABILITY OF OSMOPHILE BACTERIA OF GREAT GEOLOGICAL AGE: Kansas Acad. Sci., Trans., v. 63, no. 1, p. 31-34, Spring 1960, 3 refs.

Discussion of results and methods to determine if bacteria are present in the Permian Wellington salt of Kansas, if present are they Permian in age, and can any such bacteria be made to grow. Bacterial matter was observed in salt crystals. Every method was employed to eliminate the possibility of contamination either in the lab or in the mine. Controls were also run. Thirteen major experiments were run, and in 7, positive results in the culture of bacteria were obtained. The results suggest rather than prove the ability to culture bacteria from great geologic age. Recent evidence indicates that bacteria are not recent contaminants.--J.J. Stephens.

3-1533. Samsonov, S.K. SOME REMARKS ON THE NOVO-CASPIAN FLORA OF WESTERN TURKMENIA: Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in translation, v. 125, no. 1-6, p. 263-264, March-Apr. 1959, pub. 1960, 4 refs.

The flora and fauna of peat layers in western Turkmenia have been studied. The bulk of the peat consists of scraps of leaves, stems, roots, sedge, and other grassy remains. Seeds, zygotes of characean algae, sporangia, as well as diatoms, small gastropods, chitinous cricket shells, and shells of Cardium edule have been noted. Of particular interest were scraps of fronds of sphagnum mosses, since occurrence of these forms in Novo-Caspian time had not been previously noted so far S. in the arid zone.--F. Manheim.

3-1534. Sukachev, V.N., and others. ON THE PLANT REMAINS OF THE PERIGLACIAL ZONES OF THE CENTRAL PART OF THE RUSSIAN PLAIN: Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in translation, v. 125, no. 1-6, p. 351-354, 3 illus., table, March-Apr. 1959, pub. 1960, 21 refs.

A summary of spore-pollen analyses from plant remains from a sand and gravel pit near Moscow. The floral data, together with studies of permafrost phenomena confirm the absence of appreciable forest development, a cold climate, and permafrost in the periglacial zone of the Ostashkovsk glaciation. Fir disappeared from this locality and tree forms were restricted to pine and birch.--F. Manheim.

3-1535. Gutjahr, C.C.M. PALYNOLOGY AND ITS APPLICATION IN PETROLEUM EXPLORATION: Gulf Coast Assoc. Geol. Soc., Trans., v. 10, p. 175-187, 12 figs. incl. maps, graphs, 3 pls., 1960, 51 refs.

Palynology, the study of pollen and spores, is the only known universal method by which marine sediments can be correlated with fresh-water sediments. Study of the history of pollen analysis shows a rapid expansion in the use of this technique from 1916 onward. The Royal Dutch/Shell Group initiated palynological studies in 1938, and many oil companies now have palynological laboratories.

Pollen and spores can undoubtedly be preserved because the outer wall of the grains is extraordinarily resistant. The chemistry of this outer wall (exine) is unfortunately very poorly understood. Relation to terpenes or similar compounds has been suggested.

Although exact information concerning the distribution of pollen and spores by wind is difficult to obtain, there is considerable evidence that they can be transported very great distances. Transportation by water is important, and examples of Recent studies in the Orinoco Delta, Volga River, and United States Gulf Coast are discussed.

Pollen and spores cannot withstand prolonged oxidation. The spore and pollen wall takes up O (autooxidation). This photochemical process adds O molecules to double linkages in the pollen and spore wall, with the formation of peroxides. Since O is the main enemy of the spore and pollen wall, it is obvious that strata deposited in reducing environments often contain well-preserved pollen and spores.

Determination of ancient shorelines, age determination of Gulf Coast salt, and palynological correlations in Venezuela, Canada, and France are examples of practical applications of the palynological method. --Auth.

3-1536. Benninghoff, William S. POLLEN SPECTRA FROM BRYOPHYTIC POLSTERS, INVERNESS MUD LAKE BOG, CHEBOYGAN COUNTY, MICHIGAN: Michigan Acad. Sci., Arts & Letters, Papers, v. 45, p. 41-60, 8 figs., 7 tables, 1960, 12 refs.

One approach to improving interpretation of spectra of fossil pollen is through correlation of modern pollen rain with existing vegetation that contributes the pollen and spores. This study of pollen spectra from 7 bryophytic polsters collected in Inverness Mud Lake bog provides some guidance in the interpretation of pollen profiles from the region, especially with respect to nonarboreal pollen, when such more detailed pollen profiles are available. The regional vegetation indicators are the pollen of Pinus, Quercus, Fagus, Tsuga, Acer, Gramineae, and Compositae. Regional indicators which are influenced by local bog or swamp stands of the same entities are Picea, Betula, and Abies.

Reliable indicators of local vegetation are Cyperaceae, Ericaceae, and Thuja; if one of these is present in the pollen spectrum, the contributing plants were growing essentially on that site. Other indicators of local vegetation are less reliable; if the pollen occurs in the spectrum, the contributing plants were probably within a few hundred yards of the depositing area. These include Larix, Thuja, Scheuchzeria, Epilobium, Potamogeton, Typha, Sparganium, Sarracenia, Drosera, Myriophyllum, Viburnum, Dryopteris thelypteris, and Sphagnum.

Many other entities in the pollen spectra of these bryophytic polsters remain to be explained with respect to their representativeness.--Auth. concl.

3-1537. Fagerstrom, John A. THE FAUNA OF THE MIDDLE DEVONIAN FORMOSA REEF LIMESTONE OF SOUTHWESTERN ONTARIO: Jour. Paleontology, v. 35, no. 1, p. 1-48, diag., 14 pls., Jan. 1961, approx. 120 refs.

The numerous reefs outcropping in the region around Formosa, Ontario, have been previously considered by various authors as equivalent to the Alpena limestone of Michigan, the Delaware limestone of Ohio, the Onondaga limestone of New York, and the Detroit River group of southwestern Ontario, southeastern Michigan, and northwestern Ohio. Outcrop and subsurface lithostratigraphic evidence indicates that the last correlation is correct. By means of detailed taxonomic study of the Formosa reef fauna an attempt was made to confirm this evidence paleontologically. One hundred twenty-eight species and subspecies have been identified and illustrated of which 31 species and 2 subspecies are new, 35 have been previously described, and 59 cannot be positively identified because of poor preservation. Sixty-six percent of the previously described species and subspecies are of Onondagan age (=Bois Blanc, Detroit River, and Columbus), 16% occur in both the Onondagan and Hamilton, and 16% were heretofore known only from the Hamilton. Of the Onondagan species only 4 are known to be restricted to the Detroit River group; all 4 occur in the Amherstburg dolomite which suggests a correlation of the Formosa reef limestone with the Amherstburg.--Auth.

3-1538. Walton, William R. DIAGNOSTIC FAUNAL CHARACTERISTICS ON AND NEAR A BARRIER ISLAND, HORN ISLAND, MISSISSIPPI: Gulf Coast Assoc. Geol. Soc., Trans., v. 10, p. 7-24, 5 figs. incl. maps, graphs, 3 tables, 1960, 3 refs.

Approximately 200 sediment samples have been examined across a modern barrier island to establish the variations in faunal characteristics associated with a prototype of a subsurface stratigraphic trap. Diagnostic species variations and variations in gross population characteristics independent of species variations have been recognized.

Nine environmental zones on and near Horn Island, Mississippi, are easily recognizable on the basis of modern species composition. Exclusive of species composition, however, these zones are distinguishable on the basis of faunal diversity, population size, character of the fauna, and faunal dominance. These gross population characteristics can be used to identify nearshore-barrier island trends in the subsurface regardless of geologic age, species composition, or similarity to modern species.--Auth.

3-1539. Ivanova, E.A., and I.I. Chudinova. RECENT DATA ON DEVONIAN FAUNA IN THE KUZNETSK BASIN: Akad. Nauk SSSR, Earth Sci. Secs., in translation, v. 125, no. 1-6, p. 244-245, March-Apr. 1959, pub. 1960, 8 refs.

The Kuznetsk basin as a whole has been referred to the northern Kazakhstan zoogeographic province by Nalivkin, but the present data suggest that the northern part of the area shows influences of eastern Asiatic forms.--F. Manheim.

6. GEOPHYSICS

See also: Structural Geology 3-1444; Geohydrology 3-1675; Miscellaneous 3-1745.

3-1540. Morrison, Lawrence S., and Robert Watson. THE ELECTRONIC COMPUTER AND GEOPHYSICS: Geophysics, v. 26, no. 1, p. 40-44, 11 figs., Feb. 1961.

With the advent of electronic computers a revolution in data handling has been brought about. As yet few people outside of scientific research or accounting fields are familiar enough with these computers to know how they can be applied in their particular type of work.

Electronic computers consist of 3 basic elements: an operations register, a digital computer, and a memory unit.

The memory unit retains information in numeric form in locations that are identified by a coordinate system. Data stored in memory may be retrieved and processed in the digital computer and the results of the computation may be stored for later use. Computations are carried out in the binary or 2-digit number system.

The operations register controls the operation of the digital computer and the memory unit and acts as a link between the intent of the programmer and the internal operation of the system.

An object, given the proper code numbers describing its shape, size, color, etc., can be identified from other objects by comparison of code numbers. The speed and ability of electronic computers to compare and identify makes possible the solution of very exacting problems that otherwise would be humanly next to impossible from time considerations.

Electronic computers have been used in geophysical exploration to compute and contour derivative maps of gravity and magnetic data. They have been used to reduce gravity data to datum, compute interval and average velocities from velocity profile data and have been used to solve many nonrecurring problems.--Auth.

3-1541. Roy, Amalendu. ON SOME PROPERTIES OF RESIDUALS AND DERIVATIVES: Jour. Geophys. Research, v. 66, no. 2, p. 543-548, fig., table, Feb. 1961, 8 refs.

It is demonstrated 1) that the nth vertical derivative of a gravity or magnetic field is equal to $2^n g k^n$, where k is the mean curvature of the equipotential surface and g is the value of gravity (or vertical component of magnetic field), and 2) that the grid residuals are identical in their properties with those of the second-derivative maps, except for a constant factor, and are, therefore, superfluous and sometimes misleading.--Auth.

3-1542. Danes, Z.F. **ON A SUCCESSIVE APPROXIMATION METHOD FOR INTERPRETING GRAVITY ANOMALIES: Geophysics, v. 25, no. 6, p. 1215-1228, 5 figs, 3 tables, Dec. 1960.**

A new method for quantitative interpretation of gravity anomalies is presented. The disturbing body is represented by a finite number of vertical prisms arranged on a predetermined, regular grid. The horizontal dimensions of the individual prisms are small enough that they can be approximated by vertical-line mass elements at the axis of the prisms. Formulas for gravity due to one prism are derived and, for the case of Gulf Coast salt densities, plotted. Gravity due to the whole body is an algebraic sum of the contributions of all prisms at the appropriate depths and distances.

The method makes possible the direct interpretation by successive approximations by introducing proper geologic limitations. All the numerical work can be conveniently done on a high-speed digital computer. The method is especially suitable for features with predominant vertical dimension such as salt domes and igneous plugs. It gives at least the same, and possibly higher, degree of accuracy as the graphical dot chart methods and, carried out on a digital computer, should be about 2,000 times faster. --Auth.

3-1543. Yungul, S.H. **GRAVITY PROSPECTING FOR REEFS: EFFECTS OF SEDIMENTATION AND DIFFERENTIAL COMPACTION: Geophysics, v. 26, no. 1, p. 45-56, 9 figs., table, Feb. 1961, 16 refs.**

The classical questions are: "Do reefs create recognizable gravity anomalies?" "If and when they do, then what causes these anomalies?" To find the answers to these questions, first a study of the case histories was made. It indicated that deeply buried, "isolated," organic reefs frequently create recognizable but "mysterious" gravity anomalies, and that there is no evident direct relation between the reef mass and the gravity anomaly. To find out the causes of these anomalies, the field of investigation proved to be so large that this paper could be entitled "a tentative density analysis of the sedimentary subsurface." The reef mechanism and the depositional processes are such that there is a concentration of sand in the over-reef section. Densities in clay and sand mixtures were investigated in terms of composition and depth of burial. The sand concentration alone is capable of creating shallow positive and deep negative density contrasts sufficient to account for the major part of the gravity anomaly. The gravity effect of a hypothetical reef was calculated. The result was very much like those actually observed. The gravity anomaly depends mainly on what has happened after the reef was buried, and not on the contrast at the reef level.--Auth.

3-1544. Behrendt, John C., and George P. Woollard. **AN EVALUATION OF THE GRAVITY CONTROL NETWORK IN NORTH AMERICA: Geophysics, v. 26, no. 1, p. 57-76, 5 figs., 13 tables, Feb. 1961, 6 refs.**

Observations with a LaCoste and Romberg geodetic gravimeter having a very low nearly linear drift rate, a high reading precision, and a world-wide range were made at approximately 300 sites in order to check and extend the gravity control network in North America. The sites occupied were mostly at former gravimeter bases located at airports, harbors, universities, and pendulum stations. The instrument was calibrated against the North American standardization range of pendulum measurements from Paso de Cortes, Mexico, to Fairbanks, Alaska, using the weighted mean values of the observations established with the U.S. Coast and Geodetic Survey, Cambridge University (England), and Gulf-University of Wisconsin pendulum equipment. A statistical evaluation of the precision of the network based on reoccupations at 40 major control stations gives an estimated standard deviation of 0.08 mgal. The airport network of bases previously reported by Woollard that was established with high range Worden gravity meters was found to require a systematic correction of 0.3 mgal. per 1,000 mgal. change because of the difference in calibration standard used. The adjusted values for the 40 airport stations reoccupied agree on the average to 0.2 mgal. with the results of this study. The reoccupations of the old pendulum observation sites of the U.S. Coast and Geodetic Survey suggest that much of this network is in error by over 3 mgals. Descriptions of sites occupied and the principal facts for position, elevation, observed gravity, and free-air and Bouguer anomalies are presented.--Auth.

3-1545. Tyapkin, K.F. **THE INTERPRETATION OF GRAVITATIONAL ANOMALIES CAUSED BY FINITE CYLINDRICAL BODIES: Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in translation, v. 125, no. 1-6, p. 337-338, March-Apr. 1959, pub. 1960, 4 refs.**

Interpretation of gravity anomalies is often carried out by assuming that the anomalies are caused by one-dimensional bodies. The present paper investigates the magnitude of inaccuracies caused by such assumptions in the case of finite cylindrical bodies. A method is developed whereby errors from the one-dimensional assumption may be reduced using a series of approximations.--F. Manheim.

3-1546. Andreasen, Gordon E., and others. **GEOLOGIC INTERPRETATION OF MAGNETIC DATA IN THE COPPER RIVER BASIN, ALASKA: U.S. Geol. Survey, Repts., Open-File Ser., no. 597, 35 p., 5 maps (4 in pocket), profiles, 1960, 15 refs.**

An aeromagnetic survey was made of approximately 6,500 sq. mi. of the Copper River basin, Alaska, in 1954 and 1955. The survey area is bounded approximately by the Alaska Range on the N., the Wrangell Mountains on the E., the northern Chugach Mountains on the S., and the Talkeetna Mountains on the W. Continuous total intensity magnetic data were recorded along N.-S. flight lines spaced 1 mi. apart.

The magnetic data, compiled as a total intensity contour map, show patterns that closely parallel the generally arcuate geologic "grain" and seem to correlate with lithology and with geologic structure. Areas where volcanic rocks crop out are indicated by characteristic configuration of magnetic contours. The magnetic data suggest that Lower Jurassic volcanic rocks exposed in the Talkeetna and northern Chugach Mountains underlie sedimentary rocks in the SW. quadrant of the survey area. The data also indicate that Tertiary and Quaternary lavas of the Wrangell Mountains occur at shallow depths in the eastern part of the Copper River basin in the vicinity of Mt. Drum. Alternating bands of high and low magnetic values that characterize much of the northern third of the survey area are interpreted to be products of the plutonic rocks and metamorphosed volcanic and sedimentary rocks that crop out at many places in this area.

Two major areas of low magnetic gradient outline areas where sedimentary rocks may be thick. One area is located in the SW. part of the survey area; another larger area occupies most of the SE. quadrant of the Copper River basin. Negative gravity anomalies, also indicating areas where sedimentary rocks may be thick, correlate well with the areas of low magnetic gradient.--Auth.

3-1547. Irving, E., and D.H. Tarling. THE PALEOMAGNETISM OF THE ADEN VOLCANICS: Jour. Geophys. Research, v. 66, no. 2, p. 549-556, 6 figs., 4 tables, Feb. 1961, 16 refs.

The directions and intensities of the natural remanent magnetization of 164 specimens from 12 sites in the Aden volcanics have been measured. The stability of these directions in strong alternating fields is demonstrated. The results, besides providing the first information about the secular variation and reversals of the earth's magnetic field in low latitudes during the late Cenozoic, were also found to be of interest in connection with the origin of the Red Sea. The directions deviate systematically from true N., the average declination being N. 7°W. This deviation could be due to an anticlockwise rotation of Arabia, relative to Africa, by an amount sufficient to account for the formation of the Red Sea. However, explanations other than rotation are possible, and these cannot be tested until results are available from NE. Africa.--Auth.

3-1548. Troitskaya, V.A. PULSATION OF THE EARTH'S ELECTROMAGNETIC FIELD WITH PERIODS OF 1 TO 15 SECONDS AND THEIR CONNECTION WITH PHENOMENA IN THE HIGH ATMOSPHERE: Jour. Geophys. Research, v. 66, no. 1, p. 5-18, 12 figs., 3 tables, Jan. 1961, 24 refs.

The first results of investigations of earth current pulsations in the range of periods of 1 to 15 sec. are presented. Data of earth current stations located in the Arctic (5 stations), in the Antarctic (2 stations), and in middle latitudes of the U.S.S.R. (10 stations), as well as data of high-sensitivity installations for magnetic-field ($\underline{Z}$) registration at 3 stations, were used. Several characteristic types of pulsations were defined in this range of periods, and their correlation with phenomena in the high atmosphere was studied, among them: a) short irregular pulsations ($\underline{T} \sim$ 1-15 sec.) composing the microstructure of several forms of macroscopic disturbances of the magnetic field and showing a close correlation with aurora; and b) pulsations of the 'pearl' type ($\underline{T} \sim$ 1-4 sec.), distinguished by their regular form and showing a correlation with cosmic-ray intensity bursts in the stratosphere.

The main features of magnetic-storm microstructure, as well as the microstructure of SSC, are given. The importance of the occurrence during magnetic storms of 'pulsations with diminishing periods' and correlation studies with high-atmosphere phenomena is stressed. The dependence on local time of the fine structure of SSC is described. Contrary to some theoretical expectations the time difference between the first movements due to SSC was found to be very small; the movements may even have been simultaneous. For the Argus III explosion the onset time of oscillation was found to be within 1 sec.--Auth.

3-1549. Yungul, S.H. TIME VARIATIONS OF THE ELLIPTICITY AND PREFERRED DIRECTION OF THE Pc TELLURIC FIELD: Jour. Geophys. Research, v. 66, no. 2, p. 557-561, 8 figs., Feb. 1961, 3 refs.

The objective was to determine the preferred direction of the telluric currents, at one point on the earth, that would depend only on the geologic setting. This is called the direction of the 'geologic ellipse.'

From 6 days' recording an experimental relation between the variations of the azimuth of the long axis and the ellipticity of the statistical 'telluric ellipse' was established. By means of such a relation, it is possible under favorable conditions to obtain the direction of the geologic ellipse from only a few hours' records, although the azimuth of the 10-min. statistical telluric ellipse may vary 100° in 3 hours, and that of the daily statistical telluric ellipse may vary a few tens of degrees from day to day.--Auth.

3-1550. Wescott, E.M. MAGNETIC AND TELLURIC CURRENT DISTURBANCES IN ALASKA: Geophysics, v. 25, no. 6, p. 1242-1250, 5 figs., table, Dec. 1960, 8 refs.

Much of Alaska lies in or near the auroral zone, where magnetic and telluric current disturbances are large compared to those at lower geomagnetic latitudes. Pronounced and different diurnal variations of disturbance are evident from analysis of $\underline{K}$ indices from Barrow, College, and Sitka magnetic observatories. The quietest period for magnetic or electrical surveying is the late morning and afternoon hours locally.

Recordings of telluric current disturbances can be used as a sensitive indicator of ionospheric activity. The large amplitude and rich frequency spectrum of the telluric currents suggests their use as a prospecting tool in Alaska.--Auth.

3-1551. Vozoff, K. NUMERICAL RESISTIVITY INTERPRETATION: GENERAL INHOMOGENEITY: Geophysics, v. 25, no. 6, p. 1184-1194, 6 figs., Dec. 1960, 6 refs.

A linear approximation is developed for the equation of conduction in a medium where resistivity is an arbitrary function of $\underline{x}$, $\underline{y}$, and $\underline{z}$. This is applied by assuming the earth to be subdivided into small, homogeneous blocks of arbitrary resistivity. Under this approximation, the apparent resistivity is just the sum of the effects of the individual blocks. The equations are linear, and surface apparent resistivity data can be inverted to yield block resistivities.

The quality of the approximation has been checked by comparison with model measurements in 2 situations: remote current source (telluric method), and local current source (resistivity method). It was found that the results are satisfactory provided that the proper type of expression is used for the effect of the resistivity contrast of each block.--Auth.

3-1552. THE SEISMIC PROFILER: Oceanus, v. 7, no. 1, p. 16-19, 5 illus., Sept. 1960.

The seismic profiler operates on the principle of the echo sounder differing basically by using a broad spectrum pulse, 200 to 1,000 cycles per second, generated from shorted high-voltage condensers. It has been used successfully to determine the position of firm bedrock in waters ranging in depth from 10 to several hundred fathoms and was recently used to assist in locating the route for the planned English Channel tunnel.--M. Russell.

3-1553. Seabrooke, David S. **ANOMALOUS EVENTS ON THE REFLECTION SEISMOGRAM: Geophysics, v. 26, no. 1, p. 85-99, 26 figs., Feb. 1961, 6 refs.**

Anomalous events, i.e.; events other than simple reflections, are becoming more and more evident with the advent of magnetic tape and the various types of display sections such as variable area, variable density, full trace, etc. Recognition of these events, such as multiple reflections, diffractions, etc., is of considerable importance if the interpreter is to make optimum use of his data. A knowledge of the characteristics of the anomalous events likely to be encountered aids in their identification. Simple parameters, viz., arrival time, apparent dip stepout and normal moveout, readily obtained from the reflection seismogram, may be used to enable the problem to be approached quantitatively. Under the general headings: direct, refracted, reflected, and diffracted energy, air waves, surface waves, ghost reflections, simple multiples, complex multiples, diffractions, reflected refractions and refracted reflections are discussed. An example of a simple analytical attempt to solve an unusual offshore multiple problem is briefly described.--Auth.

3-1554. Aki, Keiiti. **FURTHER STUDY OF THE MECHANISM OF CIRCUM-PACIFIC EARTHQUAKES FROM RAYLEIGH WAVES: Jour. Geophys. Research, v. 65, no. 12, p. 4165-4172, 12 figs., 3 tables, Dec. 1960, 8 refs.**

The source functions of 3 earthquakes in the western Pacific are obtained from Rayleigh waves recorded at many IGY stations over the world. The method of interpreting the source function, which was proposed in a previous paper, is applied to these source functions. It is found that the pattern of the force at the source is quadrant for all 3 earthquakes, in accordance with the model adopted in the fault plane studies. One of the 2 nodal lines is found to be nearly parallel to the trend of the seismic zone for each of these earthquakes, and if we take this nodal line as the actual fault, the slip directions are right hand for all of them. The result from the recent Chilean shocks also supports the hypothesis that right-hand strike-slip prevails along the circum-Pacific earthquake belt.--Auth.

3-1555. Benioff, Hugo, and others. **EXCITATION OF THE FREE OSCILLATIONS OF THE EARTH BY EARTHQUAKES: Jour. Geophys. Research, v. 66, no. 2, p. 605-619, 12 figs., 2 tables, Feb. 1961, 14 refs.**

The free oscillations of the earth have been experimentally verified from an analysis of strain seismograph and pendulum seismograph recordings made in California and Peru from the great Chilean earthquake of May 1960. Both spheroidal and torsional oscillations were revealed by a power spectral analysis of the seismograms. The gravest spheroidal mode shows a split spectral peak with periods of 54.7 and 53.1 minutes. The theoretical prediction for the Bullen B model according to Alterman, Perkeris, and Jarosch is 53.7 min. The oscillations were observed for all modes up to 38 with corresponding periods as short as 3.7 min. For the higher modes, agreement in the observed period is found between the Chilean earthquake and the Kamchatka earthquake of 1952. In almost all cases agreement between experimental and theoretical predictions is close. Differences which occur should make it possible to discriminate between the several earth models which have been proposed.

From the width of the spectral peak, values of the dissipation function Q^{-1} for the earth could be determined with an accuracy greater than was previously possible. For the spheroidal mode S_3($T = 35.5$ min.), $Q = 380$, and for the mode S_{18} ($T = 6.2$ min.), $Q \approx 170$. On the assumption that Q is independent of frequency, this implies a higher Q in the core than in the mantle.

A method is described for deducing the fault length and rupture velocity from analysis of phase difference between components of ground motion. Preliminary results indicate a fault length for the Chilean earthquake of about 1,000 km. and rupture velocities in the range 3 to 4 km./sec.--Auth.

3-1556. Ness, Norman F., and others. **OBSERVATIONS OF THE FREE OSCILLATIONS OF THE EARTH: Jour. Geophys. Research, v. 66, no. 2, p. 621-629, 10 figs, 2 tables, Feb. 1961, 11 refs.**

Free oscillations of the earth excited by the Chilean earthquakes of May 1960 were recorded with high precision at Los Angeles by a LaCoste-Romberg tidal gravimeter. Spectral analysis of 4.6 days of record sampled at 1-min. intervals shows that the spheroidal modes of type ${}_0S_l$, where l - 2, 3, 4, . . ., 40, 41, were excited at periods in almost all cases within 1% of the theoretical predictions of Alterman, Jarosch, and Pekeris, based on the Gutenberg earth model. In addition, the first and second overtones for several modes have been identified. The Gutenberg model of the earth is in slightly better accord with the observations than is the Bullen model B.

Upper and lower limits for the Q's of these modes have been derived from the observations. These, in general, are of order 200 to 400, but the fundamental dilatational mode ${}_0S_0$ with a period of 20.46 min., for which shear stresses are absent, has a Q of at least several thousand and was observed even during quiet periods a month after the Chilean earthquakes. Three of the low-order modes are split, an effect which is ascribed to the earth's rotation.--Auth.

3-1557. Alsop, Leonard E., and others. **FREE OSCILLATIONS OF THE EARTH OBSERVED ON STRAIN AND PENDULUM SEISMOGRAPHS: Jour. Geophys. Research, v. 66, no. 2, p. 631-641, 7 figs., 3 tables, Feb. 1961, 16 refs.**

Spectral analyses of seismograms of the great Chilean earthquake of May 22, 1960, from a newly installed strain seismograph at Ogdensburg, New Jersey, and from pendulum seismographs at Palisades, New York, have revealed spectral peaks corresponding to fundamental spheroidal modes 2 to 34, fundamental torsional modes 2 to 9, and the first overtone of the second spheroidal mode. Other peaks, some of which may be overtones, occur in the spectra but are not yet identified. Amplitudes of some observed spectral peaks vary radically between 2 time intervals on the same record. The peaks do not decrease in amplitude according to any simple law, and, rarely, an increase in amplitude with time is observed, indicating the apparent acquisition of energy in the mode between the time intervals. The periods of the graver modes of oscillation, both spheroidal and torsional, are in agreement with the theoretical values of Alterman, Jarosch, and Pekeris. The periods of the fundamental spheroidal oscillations between 250 and 500 sec. have been determined very accurately. These periods show excellent agreement with theoretical values calculated by Bolt and Dorman for a mantle with velocities according to the Gutenberg model and densities according to the Bullen model A. Also, phase velocities obtained from these periods are in agreement with Rayleigh wave phase velocities observed directly from the same earthquake by Brune, Nafe, and Alsop. Good agreement is also observed between torsional periods and theoretical values of Satô, Landisman, and Ewing, based on velocities of Jeffreys and densities of Bullen model A.--Auth.

3-1558. Herrin, Eugene T. ON $\overline{P}$ AND L_g: Jour. Geophys. Research, v. 66, no. 1, p. 334-335, table, Jan. 1961, 6 refs.

The results obtained by Herrin and Richmond in their paper on propagation of the L_g phase (GeoScience Abstracts 2-2278) contained an error concerning the partitioning of energy between Sv and P waves. This error is corrected and the revised results tabulated; the propagation of $\overline{P}(II_g)$ phases recently reported by Shurbet is analyzed in their light.

Only the sedimentary basin model in the table would allow propagation of P waves within the L_g wave guide; for all other models there is almost complete transformation from P to Sv at the free surface, resulting in high amplitude L_g but no detectable $\overline{P}(II_g)$. The sedimentary basin model assumes 5 km. of shale and limestone, increasing rapidly in velocity with depth, above the granite layer. The wave guide in such a model would allow considerable propagation of $\overline{P}$ by multiple reflections, with reflections at the free surface. The mean surface velocity of $\overline{P}$ in such a wave guide would be 5.84 km./sec., which agrees well with Shurbet's average group velocity value of 5.81 km./sec.

The sedimentary basin model predicts an L_g group velocity of 3.35 km./sec. associated with $\overline{P}$ propagation at 5.84 km./sec.; thus records that show $\overline{P}$ might be expected to show L_g arrivals with group velocities less than the average value of 3.45 to 3.50 km./sec. The L_g group velocity for the Hughes granite model agrees well with Press's value of 3.54 ± 0.02 km./sec. for California. In fact, the propagation of $\overline{P}$ appears to be possible only in restricted regions of the continents where thick sections of low-velocity sediments exist.--D.B. Vitaliano.

3-1559. Dix, C. Hewitt. THE REFLECTED SEISMIC PULSE: Jour. Geophys. Research, v. 66, no. 1, p. 227-233, 3 figs., Jan. 1961, 4 refs.

The theory originally due to Cagniard is recast in a form that makes the approximate numerical calculation of the shape of the reflected pulse simple. A new set of potentials is introduced from which the displacement components can be calculated by differentiations that are easier to perform than those with the usual scalar and vector potentials. We use 4 potentials, 2 for the vertical components and 2 for the horizontal components of displacement. The irrotational and rotational vertical-displacement components are found by differentiation of the potentials with respect to time. The horizontal-displacement contributions are derived by a single horizontal differentiation. For the rotational parts the number of differentiations is reduced from 2 to 1. The time differentiation is much easier to carry out than the space differentiations for the forms used in the present paper. A numerical example, selected to throw some light on the problem of securing reflections from the Mohorovičić 'discontinuity,' is worked out. The variation of shape and strength of the reflection with time and with distance from source to receiver is studied in the example.--Auth.

3-1560. Dix, C. Hewitt. ELASTIC PULSE REFLECTION - EVALUATION OF SOME DETERMINANTS: Jour. Geophys. Research, v. 66, no. 1, p. 235-236, Jan. 1961, ref.

The fourth-order determinants that occur in the theory of reflection are split into a sum (denominator) and difference (numerator) of 2 much simpler determinants. This makes the algebra much simpler. It also makes the form similar to that familiar for normal incidence.--Auth.

3-1561. Fredricks, R.W., and Leon Knopoff. THE REFLECTION OF RAYLEIGH WAVES BY A HIGH IMPEDANCE OBSTACLE ON A HALF-SPACE: Geophysics, v. 25, no. 6, p. 1195-1202, 4 figs., Dec. 1960, ref.

The reflection of a time-harmonic Rayleigh wave by a high impedance obstacle in shearless contact with an elastic half-space of lower impedance is examined theoretically. The potentials are found by a function-theoretic solution to dual integral equations. From these potentials, a "reflection coefficient" is defined for the surface vertical displacement in the Rayleigh wave. Results show that the reflected wave is $\pi/2$ radians out of phase with the incident wave for arbitrary Poisson's ratio. The modulus of the "reflection coefficient" depends upon Poisson's ratio, and is evaluated as $\gamma_R = 0.265$ for $\sigma = 0.25$.--Auth.

3-1562. Knopoff, Leon, and Anthony F. Gangi. TRANSMISSION AND REFLECTION OF RAYLEIGH WAVES BY WEDGES: Geophysics, v. 25, no. 6, p. 1203-1214, 10 figs., table, Dec. 1960, 3 refs.

Experimental observations have been made of the transmission and reflection of Rayleigh waves by wedges. Results are reported for Rayleigh waves in Al wedges. It is observed that the wave shapes of the transmitted and reflected waves differ from that of the incident wave and depend on the angle of the wedge. The change of shape is attributed to an interference between part of the incident wave-form and the radiation from a line source placed at the vertex. A procedure is given for the calculation of the partition between the 2 terms.--Auth.

3-1563. Brune, James N., and others. GROUP AND PHASE VELOCITIES FOR RAYLEIGH WAVES OF PERIOD GREATER THAN 380 SECONDS: Science, v. 133, no. 3455, p. 757-758, graph, March 17, 1961, approx. 15 refs.

Recent theoretical and experimental investigations of the periods of free spheroidal oscillation of the earth have shown good agreement. These data are used to determine group and phase velocities for Rayleigh waves of period greater than 380 secs. The velocities so obtained are compared with those determined from analysis of progressive waves. It is concluded that group and phase velocities determined by either of the 2 methods are in agreement.--Auth.

3-1564. Auberger, Michel, and John S. Rinehart. ULTRASONIC VELOCITY AND ATTENUATION OF LONGITUDINAL WAVES IN ROCKS: Jour. Geophys. Research, v. 66, no. 1, p. 191-199, 11 figs., 3 tables, Jan. 1961, 22 refs.

Hughes' pulse technique for measuring longitudinal velocities has been adapted and extended to measure attenuation of longitudinal waves in the frequency range from 250 to 1,000 kc./s. Data for velocity and attenuation in 8 different rocks (3 granites, 1 porphyry, 2 sandstones, 1 limestone, and 1 marble) are given at 8 different frequencies ranging from 250 to 1,000 kc./s. The values of attenuation measured have been found to be much higher than for metals and plastics in the same frequency range. They lie between 1 and 37 decibels per centimeter. All of the curves of attenuation versus frequency show one or several peaks, none of the curves indicating a marked law of increase or decrease of attenuation with frequency. In one granite, in the limestone, and in the marble successive peaks occur at harmonic frequencies. A comparison between the wavelengths for which the peaks occur and the grain size of the rocks shows a good agreement for the coarse-grained rocks between the frequencies of occurrence of the peaks and the resonance frequencies of the largest crystals of the rocks, indicating a very large effect of the frictional boundary losses on attenuation when the wavelength approaches the grain size of the rock. --Auth.

3-1565. Haskell, N.A. CRUSTAL REFLECTION OF PLANE SH WAVES: Jour. Geophys. Research, v. 65, no. 12, p. 4147-4150, fig., Dec. 1960, 7 refs.

An equation has been derived for the amplitude of the free surface displacement due to plane SH waves incident at any angle at the base of a layered crust. Numerical computations have been carried through for the case of a single-layered model of the continental crust. At any given angle of incidence the surface amplitude goes through a series of minima and maxima at periods which, in the single layered case, are harmonically related. At nearly grazing angles of incidence the surface amplitude is relatively small except at periods in the neighborhood of the cutoff periods of the second- and higher-order Love-wave modes.

The results throw some doubt on the 'whispering gallery' effect as an explanation of the mode of propagation of long-period (20 to 30 sec.) S waves at S_n velocity.

Applied to the case of an alluvial layer over a hard-rock basement, the theory appears to give an adequate explanation of the abnormally large amplitudes that occur on unconsolidated formations in the epicentral region of earthquakes.--Auth.

3-1566. Zharkov, V.N. ON THE PHYSICAL NATURE OF WAVEGUIDES (STRATA WITH LOWERED VELOCITY) IN THE UPPER REGIONS OF THE MANTLE AT DEPTHS OF 50-200 KM: Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in translation, v. 125, no. 1-6, p. 320-322, 2 figs., March-Apr. 1959, pub. 1960, 9 refs.

A theory of Gutenberg's waveguides in the upper mantle is developed. Explanations based on phase changes, variable composition, and temperature effects meet with difficulties and are not adequate to explain the behavior of "S" and "P" waves in the layer. It is suggested that the upper mantle has a polycrystalline structure and that at sufficiently high temperatures viscous slipping between grains produces a sharp drop in the modulus of elasticity in the rock. This drop in the modulus of elasticity is held to be responsible for the reduction of velocity in the layer.--F. Manheim.

3-1567. Fry, John C., and Russell W. Raitt. SOUND VELOCITIES AT THE SURFACE OF DEEP SEA SEDIMENTS: Jour. Geophys. Research, v. 66, no. 2, p. 589-597, 6 figs., 3 tables, Feb. 1961, 22 refs.

A study of the initial amplitude of reflection of explosive sound from the sea floor in the Pacific has shown many cases in which the amplitude decreases with increasing angle of incidence and becomes negative at angles of about 74° to 80°. If the sediment can be treated as a fluid, the angle of phase change gives a measure of the sound velocity in sediments at the sea floor. Throughout most of the Pacific, velocities average about 2% less than the bottom-water velocity. At some stations, notably those in the Chilean and Aleutian trenches, in the Hawaiian deep, and off the western coast of the United States, sediment velocities were found to be higher than the sound velocity in the overlying water, suggesting the effect of turbidity-current deposits in these areas. Illustrations of these 2 types of reflection from the sea floor are presented.--Auth.

3-1568. Slichter, Louis B., and Michele Caputo. DEFORMATION OF AN EARTH MODEL BY SURFACE PRESSURES: Jour. Geophys. Research, v. 65, no. 12, p. 4151-4156, fig., 2 tables, Dec. 1960, 8 refs.

The surface displacements of a spherical earth model consisting of a homogeneous elastic shell enclosing a fluid core are considered, when the surface stress consists of a uniform pressure over equal antipodal circular caps and is zero elsewhere. On the earth, local loads are generally associated with geological structures, ice loads, or the ocean tides. In the present theory, the gravitational effects arising from the deformations are not included - such effects are small when the radius of the loaded area is small.

Values of the surface displacements are listed for 4 values of the radius of the pressure cap, and for values of the elastic constants which correspond to a simplified representation of Bullen's model. In the shell the elastic constants λ_2 and μ_2 are 14/11 x 10^{12} and 10^{12}, respectively, corresponding to a Poisson's ratio of 0.28. The value of the outer radius of the shell, r_2, is 6.371 x 10^8 cm.; the inner radius, r_1, is $0.545 r_2$. Within the core, $\mu_1 = 0$, and $\lambda_1 \mu_2^{-1} = 8$. The computed results are easily modified for other values of λ_1 and μ_2, provided the value of Poisson's ratio in the shell remains unchanged. The geophysical implications of the results are discussed.--Auth.

3-1569. Peselnick, Louis, and William F. Outerbridge. INTERNAL FRICTION IN SHEAR AND

SHEAR MODULUS OF SOLENHOFEN LIMESTONE OVER A FREQUENCY RANGE OF 10^7 CYCLES PER SECOND: Jour. Geophys. Research, v. 66, no. 2, p. 581-588, 6 figs., table, Feb. 1961, 11 refs.

The internal friction in shear and modulus of rigidity of dry Solenhofen limestone has been investigated over a frequency range from 4 c.p.s. to 10 Mc/s at room temperature. The results found are: 1) The rigidity modulus is constant ($U = 2.64 \times 10^{11}$ dynes/cm.^{2}) to within ± 2% over the total frequency range covered, provided that the samples have the same density. 2) The shear internal friction (as measured by the logarithmic decrement) in the cycle-per-second frequency range is about a factor of 5 lower than the internal friction in the megacycle frequency range; the logarithmic decrement at 4 c.p.s. $= 3.4 \times 10^{-3}$, the logarithmic decrement at 10^7 c.p.s. $= 17 \times 10^{-3}$. 3) The shear internal friction in the infrasonic frequency range increases by 18% with the application of a 7.2-kg./cm.^{2} static axial tensile stress, but no large change in the internal friction occurs for axial compressive stresses of the same magnitude. 4) The shear internal friction is strain-dependent even for strains as small as 10^{-6}, a static axial tensile stress being superposed on the dynamic torsional stress.--Auth.

3-1570. Viksne, Andris, and others. EFFECT OF POROSITY, GRAIN CONTACTS, AND CEMENT ON COMPRESSIONAL WAVE VELOCITY THROUGH SYNTHETIC SANDSTONES: Geophysics, v. 26, no. 1, p. 77-84, 5 figs., Feb. 1961, 12 refs.

Compressional wave velocities through 36 synthetic sandstone cores were measured and related to several of their physical properties, namely, porosity, manufacturing pressure, grain contacts, and amount of cement. The cores were composed of Ottawa sand grains averaging 0.21 mm. in diameter and commercial Grefco cement; the manufacturing pressure was varied from 4,000 to 10,000 p. s. i; the cement content by volume was varied from 10 to 100%; the effective porosities ranged between 2.1 and 30.4%; and the compressional wave velocities ranged between 9,170 and 17,420 ft. sec. All velocity measurements were taken at room temperature and atmospheric pressure using cores that contained only air in the pore space.

The results are presented in graphic form, showing the relationship between the compressional wave velocity and manufacturing pressure, porosity, and cement content. For Grefco cement contents between 10.0 and 17.5%, the compressional wave velocity is controlled by the manufacturing pressure and the porosity. A change in manufacturing pressure of 1,000 p. s. i changed the compressional wave velocity by 1% for cores having porosities of about 23% and by about 3% for cores having porosities of about 28%. A decrease in porosity of 1% increased the velocity by an average of 1.4% for effective porosities between 23 and 26%. The velocity is also dependent, to a great extent, on the number of grain contacts which is intimately associated with the manufacturing pressure, and the cement content which is intimately associated with the porosity. For cement contents greater than 17.5% by volume, the sand grains float in the cement, and the analogy between the synthetic sandstone cores and natural sandstones is questionable.--Auth.

3-1571. Auberger, Michel, and John S. Rinehart. ENERGY LOSS ASSOCIATED WITH IMPACT OF STEEL SPHERES ON ROCKS: Jour. Geophys. Research, v. 65, no. 12, p. 4157-4164, 7 figs. 3 tables, Dec. 1960, 17 refs.

The coefficient of restitution for impact between steel spheres and plexiglas, and between steel spheres and 9 different rocks has been measured: granite, sandstone, limestone, and 6 marbles. The energy loss associated with the impact has been studied as a function of the sphere diameter, particularly for 3 diameters: 1/8 in., 1/32 in., and 1/64 in. Such a study permits a correlation with attenuation of shear wave as a function of frequency in the frequency range of 30 to 240 kc./sec. Attenuation has been found to be strongly dependent on the main constituents of the rocks, their grain size, and the nature and size of their intergranular particles. Attenuation increases with the number of grain boundaries per unit volume and is lowered when the intergranular cement is made up of grains a few microns thick. Shear attenuation is several times larger than longitudinal attenuation in most of the rocks tested. --Auth.

3-1572. Nolting, Robert P. ACCURATE DEPTH DETERMINATION OF THE VELOCITY SURVEY WELL PHONE: Geophysics, v. 26, no. 1, p. 100, fig., Feb. 1961.

Many velocity surveys have been shot in which the actual depth of the well phone was in question at one or more of the levels shot in the borehole. Accurate depth control of the well phone can be established by fully utilizing the geophysical tools that are normally run in the borehole. Most velocity surveys are shot with the well phone and other logging equipment connected into one logging tool; by running a section (100 ft.) of one of the standard logs either immediately before or after the check level is shot, this section of log can be correlated to the standard log and depth of the well phone established from this correlation.--D. B. Vitaliano.

3-1573. Gretener, P. E. F. AN ANALYSIS OF THE OBSERVED TIME DISCREPANCIES BETWEEN CONTINUOUS AND CONVENTIONAL WELL VELOCITY SURVEYS: Geophysics, v. 26, no. 1, p. 1-11, 15 figs., Feb. 1961, 9 refs.

Discrepancies between conventionally obtained times and the integrated continuous velocity curves are analyzed (Shell tool only). It is found that these discrepancies may be ascribed to a random scatter and a systematic deviation, the integrated continuous curves being short. Possible causes of these discrepancies are discussed, but no final explanation can be offered.--Auth.

3-1574. Gaither, V. U. INDEX OF WELLS SHOT FOR VELOCITY: Geophysics, v. 25, no. 6, p. 1251-1259, Dec. 1960.

This is the 9th supplement to the original Index published in the 1944 issue of Geophysics. Information is listed on 340 well-velocity surveys not heretofore reported in any previous publication of the Index. Corrections and/or additional information on 5 previously listed surveys are also tabulated.--Auth.

3-1575. Griggs, David T., and Frank Press. PROBING THE EARTH WITH NUCLEAR EXPLOSIONS: Jour. Geophys. Research, v. 66, no. 1, p. 237-258, 4 figs., 2 tables, Jan. 1961, 22 refs.

Progress in seismology is reviewed with emphasis on the usefulness of past nuclear weapon tests in determining the internal structure of the earth. Shot times and locations are tabulated for 169 U. S. atomic explosions, with seismic data from Pasadena. The advantages of using large chemical explosions and future nuclear explosions detonated under the Plowshare program as controlled energy sources for carefully instrumented seismological experiments are discussed. Finally, an international program of explosions for seismological research is proposed, and specific suggestions are made for attacking several outstanding problems in seismology by means of chemical and clean nuclear explosions and the instrumentation network proposed at Geneva for nuclear test detection. Deep oceanic seismometer lines are proposed as a means for making important improvements in seismic knowledge of the world and possible improvements in the detection of atomic explosions.--Auth.

3-1576. Narans, Harry D., and others. SUB-BASEMENT SEISMIC REFLECTIONS IN NORTHERN UTAH: Jour. Geophys. Research, v. 66, no. 2, p. 599-603, 3 figs., 2 tables, Feb. 1961, 7 refs.

Seismic experiments were conducted in the Rozel Hills area of northern Utah with small (50 to 300 lb.) charges and geophone spreads of 703 to 1,324 m. in order to determine the possibility of obtaining normal incidence reflections from horizons within the sub-basement. It was necessary to analyze the resulting records statistically in order to differentiate between possible reflections and random noise. The seismic waves generated by 490,500 lb. of explosives fired at Promontory, Utah, on Dec. 20, 1958, were also recorded (geophone spread 412 to 546 m.).

Although the interpretation was hampered by low signal-to-noise ratios and the presence of multiple reflections, various reflected events were obtained at both sites. Two of the events yielded horizon depths of approximately 8.5 and 26.3 km., which are in close agreement with the depths of refraction horizons derived in the area by Berg, Cook, Narans, and Dolan. Evidence of other reflected events suggests that the crustal section may be more complex than is indicated by the refraction studies.--Auth.

3-1577. Tittle, Charles William. THEORY OF NEUTRON LOGGING: Geophysics, v. 26, no. 1, p. 27-39, 3 figs., 3 tables, Feb. 1961, 32 refs.

An analytical theory of epithermal neutron logging is presented. One-group diffusion theory is applied to the slowing down of neutrons from a point fast neutron source in infinite continuous media, in a single cylinder, and in concentric cylinders representing a fluid-filled borehole and the surrounding formation. Numerical results are given for the epithermal neutron flux in a water-filled hole 6 in. in diameter, passing through limestone of 10% or 30% porosity. Preliminary semiquantitative agreement is obtained with the relative response of a commercial logging instrument in the range of 10 to 100% porosity.--Auth.

3-1578. Philip, J.R. THE THEORY OF HEAT FLUX METERS: Jour. Geophys. Research, v. 66, no. 2, p. 571-579, 3 figs., table, Feb. 1961, 6 refs.

For a spheroidal heat flux meter appropriately oriented in an infinite volume of a medium in which there is a steady heat flux, f, the ratio of mean flux density through the meter to the flux density through the medium is related to ϵ, the ratio of meter conductivity to medium conductivity, by an (exact) equation of the form

$$f = \frac{\epsilon}{1 + (\epsilon - 1) H}$$

with H a function of meter geometry only. For the oblate spheroid with η (= length of minor axis/length of major axes) small, $H = 1 - (\pi/2)\eta$. It is argued that the equation should hold reasonably well for other meter shapes, and that, for thin meters, the relation $H = 1 - \alpha r$, which yields $f = 1/[1 - \alpha r(1 - \epsilon^{-1})]$, should be valid to a good approximation. α is a constant and r is the ratio of mean meter thickness in the general direction of the heat flow to the square root of the mean cross section the meter presents normal to this direction. For the oblate spheroid $\alpha = 1.70$. The assumption that meters of other shapes may be replaced for the purposes of analysis by a spheroid with the same r value is equivalent to applying the value $\alpha = 1.70$ to all meter shapes. The analog solutions of Portman for the square plate meter yield $\alpha = 1.31$ with a standard deviation of 0.59. It is shown that Portman's exponential equation and the present theory agree closely (though perhaps fortuitously) for ϵ close to or greater than 1; but the exponential equation is definitely incorrect at small ϵ.

This study indicates that the errors in heat flux meters are minimized if the following conditions are satisfied: a) the meter is made as thin as possible; b) the meter is calibrated in a medium with conductivity equal to the arithmetic mean of the extremes in which the meter is to be exposed (exact for small errors); c) the conductivity of the meter is made as great as possible. c) suggests that meters which include a sheet of an insulating material such as lucite or bakelite may not be so suitable for exposure to the full range of soil conditions as are meters consisting almost entirely of metals. However, uncertainties about thermal contact probably set a very real limit to the accuracy of heat flux meters exposed in media such as soil.--Auth.

3-1579. Jaeger, J.C. THE EFFECT OF THE DRILLING FLUID ON TEMPERATURES MEASURED IN BORE HOLES: Jour. Geophys. Research, v. 66, no. 2, p. 563-569, 3 figs., 2 tables, Feb. 1961, 6 refs.

It is generally assumed that, because of heat exchange with the drilling fluid, a bore hole must be left for some considerable time after drilling has ceased before temperature measurements can be made in it for the purpose of determining the geothermal flux. To test this point, a series of measurements of water temperature and flow were made during diamond drilling of a hole, and occasional temperature logs were taken. In this particular case it was found unnecessary at any time to wait more than a day after drilling ceased to determine the geothermal gradient to within 5%. The reason for this is shown to lie in the action of the drilling system as a heat exchanger. For the relatively small circulation of water used in diamond drilling, heat exchange takes place in restricted regions at the top and bottom of the hole. In diamond drilling, therefore, unless very large quantities of water are circulated, the temperature gradient near the center of the hole is little affected. On the other hand, in rotary drilling, in which very high fluid velocities are used, the temperature in the hole is determined almost entirely by the input temperature of the fluids.

Methods of correcting observed temperatures for the effects of drilling fluid are discussed.--Auth.

3-1580. Joyner, William B. HEAT FLOW IN PENNSYLVANIA AND WEST VIRGINIA: Geophysics, v. 25, no. 6, p. 1229-1241, 4 figs., 8 tables, Dec. 1960, 10 refs.

In order to obtain heat-flow values for 6 wells in Pennsylvania and West Virginia a simple technique was developed for estimating thermal resistivities from well-sample logs. This technique made use of average resistivity values for various categories of sedimentary rocks. The averages were calculated from available resistivity measurements on rock specimens, many of which did not come from the region in which the wells were located. The results indicate that, allowing for error in the estimates, the heat flow at the wells lies between 1.1 and 1.5 microcal/cm^2 sec. The problem of developing a more accurate technique for estimating resistivity is discussed. Such a technique would be valuable in extending our knowledge of the earth's heat flow.--Auth.

3-1581. Kane, Martin F., and Louis C. Pakiser. GEOPHYSICAL STUDY OF SUBSURFACE STRUCTURE IN SOUTHERN OWENS VALLEY, CALIFORNIA: Geophysics, v. 26, no. 1, p. 12-26, 11 figs., Feb. 1961, 23 refs.

Gravity and seismic measurements have outlined a deep subsurface trough, bounded throughout the greater part of its length by steep faults. Depths to the bedrock floor along the central part of the valley range from 3,000 to 9,000 ft. below the surface. The subsurface trough is divided into 2 parts, a narrow channellike depression near Lone Pine bounded by NW.-trending faults, and a broad basin at Owens Lake bounded by a more complex series of border faults. The bedrock ridge that crops out to form Alabama Hills is shown to extend from Independence to the N. edge of Owens Lake, nearly twice its visible extent. The main direction of faults that have formed the valley is NW.; subsidiary faults trend N., NE., and E. A fairly sharp velocity boundary within the Cenozoic valley deposits suggests a change in the rate and character of deposition which was probably the result of renewed uplift in the nearby mountains.--Auth.

3-1582. Diment, W. H., and others. CRUSTAL STRUCTURE FROM THE NEVADA TEST SITE TO KINGMAN, ARIZONA, FROM SEISMIC AND GRAVITY OBSERVATIONS: Jour. Geophys. Research, v. 66, no. 1, p. 201-214, 10 figs., 2 tables, Jan. 1961, 40 refs.

The time of the first arrival of seismic waves generated by explosions at the Nevada Test Site and recorded along a 300-km. line southeastward through Kingman, Arizona, is expressed as $T_0 = \Delta/5.2$, $T_1 = 0.34 + \Delta/6.15$, and $T_2 = 5.82 + \Delta/7.81$, where time is in seconds and the shot-detector distance (Δ) is in kilometers. Assuming constant velocities for the layers, the thicknesses are $H_0 = 1.7$ km., $H_1 = 26.7$ km., and $H_0 + H_1 \doteq 28$ km. (below a 1-km. datum). The average Bouguer anomaly is about −120 milligals, and the average elevation is about 1.1 km.

Seismograms were examined for P waves indicating the presence of other discontinuities within and below the H_2 layer, but the separation between seismic stations was too great to establish the presence of such discontinuities. A questionable alignment of weak arrivals following the T_2 refraction time by less than 1 sec. may indicate the presence of a discontinuity below 28 km. Fair alignments of strong second arrivals in the range 200 to 400 km. might be interpreted as direct P waves or channel waves in the H_1 layer.--Auth.

3-1583. Oliver, Jack E., and others. CRUSTAL STRUCTURE OF THE NEW YORK-PENNSYLVANIA AREA: Jour. Geophys. Research, v. 66, no. 1, p. 215-225, 7 figs., 4 tables, Jan. 1961, 15 refs.

Phase velocities of Rayleigh waves in the period range from 15 to 45 sec. were determined from seismograms of the Waynesburg, Pennsylvania-Ottawa, Ontario-Palisades, New York, tripartite array. A theoretical model, compatible with these data and with previously published seismic refraction data of Katz, consists of a low-velocity sedimentary layer overlying 2 crustal rock layers which in turn overlie the earth's mantle. The total crustal thickness is about 37 km.

Calculations of Rayleigh wave dispersion for a variety of theoretical models show that small variations in elastic properties from place to place may cause significant errors in the determination of total crustal thickness if such variations are neglected when the phase-velocity method is used independently. The error is considerably less if supplementary data are used in conjunction with phase-velocity data as was done in the example cited above.--Auth.

3-1584. Phipps, Rollin E. A CASE HISTORY OF THE BRONTE (ELLENBURGER) AND RAWLINGS FIELDS, COKE COUNTY, TEXAS: Geophysics, v. 25, no. 6, p. 1167-1183, 13 figs., Dec. 1960, 2 refs.

The North Bronte area interested Lion Oil Co. on the basis of surface, isopachous, and magnetic studies. A large block of acreage was acquired and explored by the seismograph. A well was drilled on the shooting and proved the shooting to be reliable. A velocity survey in this well, however, indicated that the map of the reflective event identified as Ellenburger was actually Caddo. Additional shooting was done before the Lion No. 1 Edwards, the discovery well of the Bronte (Ellenburger) field, was drilled. The discovery well of the Rawlings field was drilled by Humble on seismic information. There are 8 producing zones in these fields. Shooting costs and permit fees have remained amazingly constant through the years.--Auth.

3-1585. Ewing, John I., and others. GEOPHYSICAL MEASUREMENTS IN THE WESTERN CARIBBEAN SEA AND IN THE GULF OF MEXICO: Jour. Geophys. Research, v. 65, no. 12, p. 4087-4126, 48 figs., table, Dec. 1960, 23 refs.

The data from 48 seismic refraction profiles in the western Caribbean Sea and in the Gulf of Mexico are presented in the form of structure sections crossing the Colombian basin, Nicaraguan rise, Cayman trough, Cayman ridge, Beata ridge, Yucatan basin, Campeche bank, and Sigsbee deep. The Cayman trough has a remarkably thin crust, which suggests that it is a tensional feature. Although parts of the basins have a relatively thin crust, similar to the oceanic type, the shallower areas are intermediate or almost continental in structure. In the Gulf of Mexico the main basin is similar to typical ocean basins in structure except that the high-velocity crust is overlain by very thick sediments. The depth to the mantle is appreciably greater in the Gulf than in an ocean basin. This may be partly the result of loading by the sediments, but large scale tectonic activity is a more likely cause. The Sigsbee escarpment, the northern boundary of the main basin, appears to be the surface expression of a fault or sharp flexure in the layers beneath the unconsolidated sediments.--Auth.

7. GEOCHEMISTRY

See also: Mineralogy 3-1630; Sedimentary Petrology 3-1662; Geohydrology 3-1678; Mineral Deposits 3-1698, 3-1718.

3-1586. Lingard, A. L. SPECTROGRAPHIC DETERMINATION OF COMMON ELEMENTS IN ROCKS AND MINERALS: South Dakota Acad. Sci., Proc., v. 39, p. 48-51, 3 tables, 1960, 5 refs.

This paper describes rapid and inexpensive spectrographic analyses of rocks and minerals. Samples with known chemical composition were mixed in various proportions and necessary reagents added in different proportions. The samples were burned in 220 volt d.c. arc at 12 amperes for 30 sec. The spectrum from 2500A to 3300A was photographed. The photographic plates were developed for 4 min. at 20°C. and fixed and washed. Analytical curves from this procedure were plotted on log-log paper. This method is useful for determining Al, Ca, Fe, Mg, Mn, Si, Ti, and the oxides of several of these, and can be extended to other elements. With further refinement the method will become more precise and will have a wider range of usage.--F.V. Steece.

3-1587. Nagy, Bartholomew, and others. SEPARATION OF n-OCTADECANE-1-C^{14} FROM ASPHALTIC MIXTURES BY ELUTION CHROMATOGRAPHY: Geochim. et Cosmochim. Acta, v. 21, no. 1/2, p. 151-155, 2 figs., Dec. 1960, 6 refs.

It is often assumed that the n-heptane chromatographic fraction represents the total saturated hydrocarbon content of asphaltic matter. This assumption, however, is based on an approximation rather than on an analytically rigorous finding. C^{14}-labelled n-octadecane was mixed with the semisolid Athabasca petroleum, and the mixture was eluted with a series of solvents. The majority, but not all, of the radioactive material was recovered with n-heptane from aluminum oxide and silica gel columns. For example, combined counts equivalent to 2.32% of the n-heptane eluate counts were recorded in consecutive eluate fractions (such as in the pyridine fractions) from a Fisher alumina column. It is recommended in routine geological studies that the chromatographic fractions be analyzed by suitable means to ascertain their composition and to identify their impurities.--Auth.

3-1588. Fröhlich, F. BEITRAG ZUR GEOCHEMIE DES CHROMS [Contribution to the Geochemistry of Chromium]: Geochim. et Cosmochim. Acta, v. 20, no. 3/4, p. 215-240, 4 figs., tables, Nov. 1960, 34 refs.; text in German, abs. in English and German.

Cr has been determined in 227 rocks and minerals by means of the diphenylcarbazide colorimetric method, which was modified for this purpose. The mean error of the method, expressed as the difference between duplicate determinations, is ± 2%, and Cr contents down to 1 p.p.m. can be measured.

The analyses show that Cr is concentrated in the basic and ultrabasic rocks, while the granites investigated generally contained only about 1 p.p.m. Cr. In the basic rocks, the Cr is present in specific Cr minerals such as chromite and picotite, and also in magnetites and pyroxenes. The feldspar contains almost no Cr.

The Cr content of volcanic rocks decreases steadily with increasing SiO_2 content. Thus, the melilite basalt of Gotzenbruhl with 34.7% SiO_2 contains 1,380 p.p.m. Cr, while the Aar granite with 77% SiO_2 contains but 1 p.p.m. Cr.

Among the sedimentary rocks, high Cr contents are found in bauxites and in sedimentary Fe ore deposits. In the bauxites this is due to relative (secondary) enrichment of Cr, while in the Fe ores Cr may be associated with the Fe in a colloidal state.

Pelitic sediments show a very uniform Cr content. Of 40 samples investigated, 24 contained between 70 and 110 p.p.m. Cr., while the remainder were also fairly close to these values.

For the most part, the Cr in sediments is concentrated in the micas and clay minerals, particularly in illite.--Auth.

3-1589. Ricke, Werner. EIN BEITRAG ZUR GEOCHEMIE DES SCHWEFELS [A Contribution to the Geochemistry of Sulfur]: Geochim. et Cosmochim. Acta, v. 21, no. 1/2, p. 35-80, 2 figs., 22 tables, Dec. 1960, 90 refs.

Two chemical methods for the determination of small quantities of total and sulfide S in silicate minerals and rocks are described. Sulfate S, in general, is obtained as different from total and sulfide S. The determination of S contents down to 0.002% is possible. The mean deviation lies for contents below 0.02% at ± 0.001%; for contents between 0.02 and 0.1% at ±0.0015%.

Ninety-six mineral and 132 rock samples were analyzed. In nearly all of them, total sulfide and sulfate S were determined. The mineral analyses indicate that many rock-forming minerals contain small quantities of sulfate S. In quartz up to 0.0095%, in feldspars 0.022%, in muscovites 0.013%, in pyroxenes 0.007% and in various sorosilicates up to 0.014% sulfate S was found.

The average total S content of each mean family of igneous rocks is nearly 0.03% S. The alkali rocks usually show higher contents. S occurs in igneous rocks both as sulfide and sulfate. In gabbros the sulfate portion, when present, is very small. On the average, plutonic rocks contain more sulfide S and less sulfate S than their effusive equivalents; silicic rocks contain less sulfide S than basic rocks. The percentage of the total S that is sulfate S is higher in silicic rocks than in basic rocks. For 3 granites and 1 basalt, it could be shown that the feldspars are preferred hosts for sulfate S.

Several possibilities for the mode of sulfate S in igneous rocks are discussed. From leaching studies it seems probable that sulfate in silicate minerals appears not only in fluid inclusions, but that also replacement of SiO_4 by SO_4 in the silicate, may occur.

In sedimentary rocks the S is found both as sulfide and sulfate; mainly as sulfide in shales (average: 0.22% S), in greywackes (average: 0.13% S) and carbonate rocks (average: 0.12% S), and as sulfate in sandstones (average: 0.022% S) and pelagic sediments (average: 0.13% S). Metamorphous rocks also contain sulfide and sulfate S.

Calculations indicate that the total S contents of the oceans, of the common sedimentary rocks, and of the evaporite deposits of the earth, are almost alike, and that the S in these must to a great extent have originated from degassing magmas.--Auth.

3-1590. Sreenivas, B. L., and Rustum Roy. **OBSERVATIONS ON CATION EXCHANGE IN SOME MANGANESE MINERALS BY ELECTRODIALYSIS:** Econ. Geology, v. 56, no. 1, p. 198-203, 4 figs., table, Jan.-Feb. 1961, 9 refs.

The behavior of cations in some Mn minerals was studied by electrodialysis. Among the common manganese oxide minerals, psilomelane, hollandite, lithiophorite, chalcophanite, and hetaerolite showed no change. Cryptomelane (α-MnO_2) shows significant cation exchange, passing through an intermediate contracted cell stage. It finally changes to γ-MnO_2 after a few hours of dialysis. Braunite undergoes remarkable changes appearing to transform into bixbyite.--Auth.

3-1591. Sourirajan, S., and George C. Kennedy. **THE SYSTEM H_2O-NaCl AT ELEVATED TEMPERATURES AND PRESSURES:** California, Univ., Radiation Lab., [Pub.] UCRL-6175, 45 p., 19 figs., 4 tables, Nov. 1960, 20 refs.

The system H_2O-NaCl has been studied up to pressures of 1,240 bars and in the temperature interval 250°-700°C. The temperature and pressure of the gas-solid-liquid boundary curve have been determined, and the solubility of solid NaCl in steam up to saturation pressures has been measured. The composition of coexisting gases and liquids at pressures above the melting pressure and below the critical pressure has been determined for isotherms ranging from 350° to 700°C. The critical composition and pressure for various isotherms have been determined. The NaCl concentration of saline hot springs is not inconsistent with the postulate that the sodium chloride was transported from the magmatic hearth in gaseous H_2O.--Auth.

3-1592. Clark, Lloyd A. **THE Fe-As-S SYSTEM: PHASE RELATIONS AND APPLICATIONS:** Econ. Geology, v. 55, no. 7, p. 1345-1381, Nov. 1960; no. 8, p. 1631-1652, Dec. 1960, 14 figs., 22 tables, 97 refs.

A basis for the interpretation of Fe-As-S mineral assemblages in ores has been provided through systematic collection of physical and chemical data in the synthetic system Fe-As-S. Most interesting is the temperature limitation of 491°C. for coexistence of the commonly observed mineral pair pyrite-arsenopyrite. The As : S ratio in arsenopyrite and/or loellingite may add another to the group of geothermometry techniques now available for ore studies. The observation that Au diffuses rapidly through fine-grained arsenopyrite at temperatures above 600°C. and confining pressures up to 2,070 bars provides some insight into the relations of Au and arsenopyrite in many ores.

Equilibrium phase relations in the Fe-As-S system were determined at 600°C., and changes in assemblages were studied in the 400° to 800°C. temperature range. At 600°C. a very narrow liquid field lies along the As-S side of the ternary system between 100 and 22.8 ± 0.2 weight percent S. Tie-lines connect various parts of this liquid field to pyrite, to pyrrhotite, and to arsenopyrite. At this temperature there are also tie-lines between pyrrhotite-arsenopyrite, arsenopyrite-As, arsenopyrite-loellingite, pyrrhotite-loellingite, pyrrhotite-FeAs, and FeS-Fe_2As.

At temperatures above 600°C. synthetic arsenopyrite has the approximate composition $FeAs_{1.1}S_{0.9}$. Compositions that are S rich relative to ideal FeAsS become stable at lower temperatures and under high confining pressures. Changes in the phase assemblages at various temperatures are governed by the reactions : pyrite + arsenopyrite $\rightleftharpoons$ pyrrhotite + liquid or vapor, arsenopyrite + As $\rightleftharpoons$ loellingite + liquid or vapor, and arsenopyrite $\rightleftharpoons$ pyrrhotite + loellingite + liquid or vapor. The invariant temperature at which both liquid and vapor are present in these assemblages are 491° ± 12°C., 688° ± 3°C., and 702° ± 3°C., respectively. The first reaction was investigated at confining pressures up to 2,070 bars, at which pressure pyrite and arsenopyrite can coexist up to 528° ± 10°C.--Auth.

3-1593. Belov, N. V., and V. I. Simonov. **ISOMORPHOUS RELATIONS BETWEEN ZIRCONIUM AND TITANIUM:** Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in translation, v. 125, no. 1-6, p. 208-209, March-Apr. 1959, pub. 1960, 4 refs.

In a recent paper the present authors stated that Ti replaces Zr in zirconium silicates in the Lovozero massif. This statement should be modified to read that one may speak of isomorphism between Ti and Zr only for seidozerite, låvenite and astrophyllite-kupletskite. In these minerals the replacement of Zr by Ti is made possible by a replacement of Mg by Mn^{+3} with simultaneous reduction of Ti^{+4} to Ti^{+3}.--F. Manheim.

3-1594. Carr, R. M., and W. S. Fyfe. **SYNTHESIS FIELDS OF SOME ALUMINIUM SILICATES:** Geochim. et Cosmochim. Acta, v. 21, no. 1/2, p. 99-109, 3 figs., 9 tables, Dec. 1960, 12 refs.

The *P-T* field in which a phase or assemblage of phases may be synthesized need not be identical with that in which it is stable. This proposition is illustrated by studies in the system Al_2O_3-$4SiO_2$ under hydrothermal conditions. Three different starting materials have been used (amorphous Al_2O_3-quartz, kaolinite-amorphous silica, kaolinite-quartz) and 3 significantly different synthesis diagrams result. None can be said to represent stable equilibrium, but petrological observations indicate that results using kaolinite and quartz (the closest approach to natural starting materials) may approach most closely to equilibrium conditions. With this starting material at 30,000 lb./in.^{2}, kaolin passes to pyrophyllite at 420°C., pyrophyllite to an andalusite-like phase (here called X-andalusite, possibly the "AS(H)-II" of Aramaki and Roy) at 470°C., and X-analusite to mullite at 525°C. The writers believe that, due to prohibitive kinetic aspects of boundary reversal, it may be impossible to establish the equilibrium relations between sillimanite and andalusite by synthetic methods. --Auth.

3-1595. Ringwood, A. E. **SOME ASPECTS OF THE THERMAL EVOLUTION OF THE EARTH:** Geochim.

et Cosmochim. Acta, v. 20, no. 3/4, p. 241-259, 2 figs., Nov. 1960, 75 refs.

Empirical data relating to the thermal history of the earth are examined. Recent astronomic and geochemical evidence strongly suggests that the earth formed by accretion from an initially low-temperature gas-dust cloud of solar composition. The distribution of U, Pb, Th, and K within the earth imply that it passed through a melting or partial melting process about 4.5×10^9 years ago. This conclusion is confirmed if the core is assumed to consist dominantly of Fe-Ni. Formation of the core, which likewise occurred about 4.5×10^9 years ago would liberate sufficient gravitational energy to cause melting. Evidence in favor of melting is also provided by analogy with meteorites.

An examination is made of possible causes of this early melting stage and it is concluded that gravitational energy is chiefly responsible. Radioactive heating does not appear to be important. A critical factor in the early heating and chemical evolution is the interaction of accreting dust falling with high velocity into the primitive reducing atmosphere surrounding the earth. Because of this interaction, a metallic phase is produced by reduction.

The distribution of temperature within the earth 4.5×10^9 years ago will be given by the melting-point gradient. Recent data on the electrical conductivity of the mantle and the melting point of metals under high pressures suggest that the present temperature distribution is much less than the melting point gradient. This implies that the earth has cooled considerably.

The inferred cooling is consistent with present data on the abundance of radioactive elements in meteorites and in the earth, and also with possible modes of internal heat transfer - particularly convection and radiation.--Auth.

3-1596. Dawson, K.R., and others. A DESCRIPTION OF THE METEORITE WHICH FELL NEAR ABEE, ALBERTA, CANADA: Geochim. et Cosmochim. Acta, v. 21, no. 1/2, p. 127-144, 10 plates, 6 tables, Dec. 1960, 14 refs.

The Abee meteorite, which fell at 54°13' N. 113° W., N. of Edmonton, Alberta, on June 9, 1952, is described for the first time in this paper. The surface features and internal structures are those of a black polymict chondritic breccia. Chemical analyses have been made of the matrix and of the stony fragments, and these have been recalculated to give a mineralogical norm which corresponds with mineral identifications by X-ray diffraction. The stone consists mainly of enstatite and kamacite-taenite, with minor troilite, and accessory oldhamite, alabandite, α-cristobalite, and quartz. The metallurgical study of the Ni-Fe of the meteorite indicates that relatively coarse grains of a kamacite-cohenite intergrowth resembling pearlite with marginal areas and islands of α-2-iron are the dominant phases present. Taenite is present only as an accessory constituent. The exterior of the fusion crust contains droplets of δ-iron and very fine-grained magnetite whereas the interior of the crust contains martensite grains produced by the heating and quenching of the kamacite. --Auth.

3-1597. Hess, D.C., and R.R. Marshall. THE ISOTOPIC COMPOSITIONS AND CONCENTRATIONS OF LEAD IN SOME CHONDRITIC STONE METEORITES: Geochim. et Cosmochim. Acta, v. 20, no. 3/4, p. 284-299, fig., 6 tables, Nov. 1960, 26 refs.

Microgram quantities of Pb were volatilized from the chondrites Richardton, Holbrook, Beardsley, and Plainview and purified for mass spectrometric analysis. Aliquots of approximately $1 \mu g$ were surface-ionized by use of the boric acid technique. The isotopic compositions found range from highly radiogenic Pb in the case of Richardton to leads in the other 3 chondrites which are substantially less radiogenic than average Pb in the crust of the earth.

From our recent concentration determinations by the isotopic dilution method, it seems that the amount of Pb in Beardsley is about 0.13 p.p.m. and that in Richardton about 0.06 p.p.m. The leads in these meteorites are consistent within a factor of approximately 2 with the Pb-Pb ages and the independently measured U and Th concentrations. The Pb-Pb age for Richardton is the same as that found by Patterson for Nuevo Laredo, being 4.6 AE. The Pb concentration measured for Forest City is 0.09 p.p.m., while that for Holbrook is 0.28 p.p.m. Holbrook is quite anomalous in containing 2.5 times the amount of radiogenic Pb that can be explained by the accumulation of decay products in situ with a primeval Pb which had the isotopic composition of the Pb from the troilite in the Canyon Diablo and Henbury Fe meteorites.

The total amount of Pb on the surface of a meteorite appears to be comparable to the total amount inside. The isotopic composition of this surface Pb indicates that it is principally terrestrial Pb.--Auth.

3-1598. Goles, Gordon G., and Edward Anders. IODINE CONTENT OF METEORITES AND THEIR I^{129}-Xe^{129} AGES: Jour. Geophys. Research, v. 65, no. 12, p. 4181-4184, 2 tables, Dec. 1960, 24 refs.

I and Te abundances in chondritic meteorites were determined by neutron activation analysis. For bronzite and hypersthene chondrites (6 analyses) I abundances from 37 to 104 p.p.b. were found; for enstatite and carbonaceous chondrites (9 analyses), the range is from 127 to 560 p.p.b. The Te abundances range from 0.42 to 0.73 p.p.m. and 1.23 to 3.4 p.p.m. respectively. I^{129}-Xe^{129} decay intervals, measured from the cessation of nucleosynthesis, were calculated for the meteorites Richardton $\left(119^{+9}_{-6}\,\text{m.y.}\right)$ and Indarch $\left(97^{+17}_{-10}\,\text{m.y.}\right)$, using the continuous nucleosynthesis model. The significance of these results is discussed.--Auth.

3-1599. Hara, T., and E.B. Sandell. METEORITIC ABUNDANCE OF RUTHENIUM: Geochim, et Cosmochim. Acta, v. 21, no. 1/2, p. 145-150, 4 figs., 2 tables, Dec. 1960, 13 refs.

The ruthenium content of 15 chondrites (all "finds") averaged 1.0 p.p.m., with a range from 0.7 to 1.3 p.p.m. The metal phase of chondrites contains, on the average, 4-5 p.p.m. Ru, and the troilite phase a similar amount. Ru varies widely in Fe meteorites, the range of 17 extending from less than 1 p.p.m. to 15 p.p.m., with an average of approximately 7 p.p.m. Ru tends to vary inversely with Ni (and Pd) in irons. There seems to be a relation between the Ru content and the structure of Fe meteorites.--Auth.

3-1600. Ahrens, L.H., and others. THE UNIFORMITY OF CONCENTRATION OF LITHOPHILE ELEMENTS IN CHONDRITES - WITH PARTICULAR REFERENCE TO Cs: Geochim. et Cosmochim Acta,

v. 20, no. 3/4, p. 260-272, fig., 4 tables, Nov. 1960, 30 refs.

The paper is in 2 parts. In the first, the dispersion of concentration of the lithophile elements Li, Na, K, Rb, Mg, Ca, Sr, Ba, Al, Sc, Eu, Si, Ti, Zr, Th, and U is examined in chondrites. Where 20 or more analyses have been made, relative deviations have been calculated; these range from 5 to 29%. Some of the variation is clearly due to analytical error and it is concluded that the relative deviations of most, perhaps all, lithophile elements is near the lower limit (5%) of the above range. Such small dispersion of concentration for a wide variety of elements, including Li, K and Mg which are sensitive to fractionation, indicates that chondrites have come from a source with an exceptionally uniform composition. It is concluded further that variation of concentration of a lithophile element in the silicate phase, as distinct from the meteorite as a whole, may be even smaller and that the ratio of one lithophile element to the other lithophile elements may turn out to be extremely small indeed. Analytical data of a very high order of excellence (relative deviation of 1-2%) for all elements are evidently required to estimate such small variations precisely.

The second part of the paper is concerned specifically with Cs. This element has been estimated spectrochemically in K-Rb-Cs fractions obtained by ion exchange techniques from 6 chondrites and 7 specimens of basic rock. In the chondrites, the Cs content (ave. 0.12 p. p. m.) and the K/Cs ratio (ave. 7,000) remains constant to within the precision of the method of analysis. The magnitude of the average agrees with that (0.09 p. p. m.) of Webster, Morgan, and Smales but the small variation of the Cs concentration and of the K/Cs ratio contrasts with their observations as they report large variations (x 30 or more). The K/Cs ratio in the 7 basic rocks is fairly uniform (in contrast with granites) and similar in general magnitude to that in the chondrites. --Auth.

3-1601. O'Keefe, John A. TEKTITES AS NATURAL EARTH SATELLITES: Science, v. 133, no. 3452, p. 562-566, illus., 4 maps, diag., Feb. 24, 1961, approx. 15 refs.

A study of the distribution of meteors falling in the shower of Feb. 9, 1913 - named the "Cyrillids" - shows that the meteor display was concentrated along a NW.-SE. line extending from Minnesota out across the Atlantic at New Jersey. The distribution shows that a mechanism exists by which bodies can fall from a satellite orbit "in one or a few revolutions, without covering a complete band of latitude." It is suggested that the tektites had a lunar origin, traveled earthwards in an eccentric orbit, took on their glassy form as a result of atmospheric ablation, and were accompanied by other quantities of lunar material reaching the earth in some as yet unrecognized form. These suggestions can be reconciled with previous objections, notably those of Barnes, Kopal and Urey.--F. P. Glasser.

3-1602. Thiel, Edward C., and Richard A. Schmidt. SPHERULES FROM THE ANTARCTIC ICE CAP: Jour. Geophys. Research, v. 66, no. 1, p. 307-310, 2 figs., table, Jan. 1961, 13 refs.

A study of spherules contained in antarctic ice cores leads to improved values for the size distribution and annual mass deposit of these distinctive extraterrestrial particles. Previous estimates of the annual deposit based on collections from air and from ocean sediments have varied from 8 metric tons to 2,000,000 metric tons per year. The figure derived from the present study is 184,000 metric tons per year.--Auth.

3-1603. Amirkhanov, Kh. I., and others. THE DIFFUSION OF RADIOGENIC ARGON IN FELDSPARS: Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in translation, v. 125, no. 1-6, p. 210-212, 4 figs. table, March-Apr. 1959, pub. 1960, 3 refs.

Studies have been made of the kinetics of the diffusion of Ar^{40} from 2 specimens of Precambrian feldspar. The loss of Ar was determined by isotope dilution-mass spectrometric methods after heating size fractions of the feldspar. The results indicate that, while at a given temperature the loss of Ar^{40} takes place by diffusion, this loss is relatively insignificant. The main loss of Ar^{40} takes place at a characteristic "zero phase" for each crystal grain during which loss of Ar is very rapid.--F. Manheim.

3-1604. Ivanov, V. V., and others. SCANDIUM IN THE MINERALS OF THE QUARTZ VEINS AND GREISENS OF ONE OF THE INTRUSIONS OF THE POLOUSNYI RANGE: Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in translation, v. 125, no. 1-6, p. 242-243, 3 illus., table, March-Apr. 1959, pub. 1960, 4 refs.

Enrichments in Sc have been found in quartz-greisen mineralizations showing similarities to the classical Erzgebirge deposits of Germany. Sc is found in amounts ranging from .005% to .2% Sc_2O_3 in wolframite, cassiterite, and zinnwaldite. The paragenesis is quartz, topaz, zinnwaldite, muscovite, fluorite, wolframite, arsenopyrite, sphalerite, molybdenite, and lesser amounts of galena, pyrite, chalcopyrite, bismuthinite, and native Bi. The occurrence is in a granite massif intruding late Jurassic terrestrial sediments.--F. Manheim.

3-1605. Kretz, Ralph. THE DISTRIBUTION OF CERTAIN ELEMENTS AMONG COEXISTING CALCIC PYROXENES, CALCIC AMPHIBOLES AND BIOTITES IN SKARNS: Geochim. et Cosmochim. Acta, v. 20, no. 3/4, p. 161-191, 23 figs., 4 tables, Nov. 1960, 13 refs.

Skarns composed predominantly of Ca pyroxene, Ca amphibole, and biotite occur locally in the Grenville metamorphic terrain of the Canadian Precambrian Shield. The enclosing rocks are Grenville gneisses and limestones, gabbroic rocks, veined gneisses, and granitic rocks. The metamorphic grade of the skarns is identical to that of the enclosing rocks, namely the upper region of the amphibolite facies.

Twelve skarn specimens were selected for chemical study. An investigation is made of the concentrations of Al, Fe, Mg, Mn, Ti, Ca, Na, K, Ba, V, Cr, Zr, Y, and Sc in 11 Ca pyroxenes, 10 Ca amphiboles, and 11 biotites.

Consideration is given to the distribution of elements among coexisting minerals. Regular relationships appear when 1) the concentration of an element in a mineral is related to the concentration of the element in a coexisting mineral by a linear or nonlinear function, and 2) the linear or nonlinear function is itself a function of the concentration of another element in one or both of the coexisting minerals.

The relationships indicate that for the most part, minerals within each skarn specimen closely approached a state of chemical equilibrium.

A preliminary attempt is made to explain the distribution relationships in terms of crystal chemistry.--Auth.

3-1606. Herz, Norman, and C.V. Dutra. MINOR ELEMENT ABUNDANCE IN A PART OF THE BRAZILIAN SHIELD: Geochim. et Cosmochim. Acta, v. 21, no. 1/2, p. 81-98, fig., 9 tables, Dec. 1960, 21 refs.

Thirty-nine samples of granitic rocks from the Quadrilátero Ferrífero, Minas Gerais, Brazil, representing "mixed" ages and at least 3 distinct Precambrian ages were analyzed for 17 minor elements. The rocks are placed in 5 groups: 1) 2,400 million year old group; 2) Bação complex younger, a group of mixed rocks derived from 1) and 3); 3) 1,350 million year old group; 4) a 500 million year old gneissic group; 5) a 500 million year old silicic group, a later differentiate of a 500 million year old magma.

Compared to granitic rocks elsewhere, these Brazilian rocks are about average in Ba, Sc, Zr, Pb, Nb, Co, Ni, Be, and Mo; above average in La and Y; and below average in Cu, Sr, Ga, Sn, V, and Cr. Compared to metasedimentary rocks elsewhere in the world, metasedimentary rocks of this region are about average in all 17 minor elements.

Sr has its greatest abundance in the 2,400 million year old rocks; Ba, V, Co, Sc, Cr, Ni, and Cu in the 1,350 million year; and La, Nb, Sn, Zr, Y, and Ga in the 500 million year silicic. These abundances are in accord with the petrology and chemistry of the rocks. The 1,350 million year rocks are the most mafic of the group and should logically concentrate Ba, V, Co, Sc, Cr, Ni, and Cu which are most abundant in earlier crystallates. The 500 million year old silicic rocks are the most felsic and should concentrate La, Nb, Sn, Zr, Y, and Ga, which are all most abundant in the latest fractions of granitic magma crystallization.

The trace elements also lend support to the idea that the Bação complex rocks developed by anatexis of 2,400 million year rocks during the 1,350 million year orogeny. Cu, Sc, Ga, Zr, Sn, and Nb have about the same magnitude in the Bação and the 2,400 million year rocks and Sr, V, Co, Cr, and Ni are lower in the Bação than either the 2,400 or the 1,350 million year old rocks. This lower abundance is a probable effect of "debasification" which is also brought out by the analysis of major constituents.

The effects of a geochemical migration of the elements in this part of the earth's crust may be indicated by the increased abundance of Y in successively younger rock types. The increase of La, Nb, Pb, Sn, Y, and Zr in the 1,350 million year rocks compared to the 2,400 million year rocks might also be an effect of a secular migration.--Auth.

3-1607. Zartman, R.E., and others. HELIUM, ARGON, AND CARBON IN SOME NATURAL GASES: Jour. Geophys. Research, v. 66, no. 1, p. 277-306, 4 figs., 7 tables, Jan. 1961, 62 refs.

Thirty-nine samples of natural gases representing varied chemical compositions and geological occurrences were analyzed for their He, radiogenic Ar, and atmospheric Ar contents. The total range in the $(He/Ar)_{rad}$ ratio was found to be 1.6 to 130 with most samples having values between 6 and 25. This range of values is essentially equal to the production ratio from the U, Th, and K in average igneous rocks and a wide variety of sediments. This indicates that all of these natural gases have obtained their radiogenic gases from rather average rock types. This is true in spite of the fact that the gases range in He content from 37 to 62,000 p. p. m.

A theoretical discussion of the origin of He and Ar in natural gases is given. It can be shown from the ratio of N to atmospheric Ar that most of the N in these gases cannot come from the entrapment of air. From a consideration of the concentration of atmospheric Ar in natural gases it is possible to estimate the proportion of gaseous and aqueous phases assuming diffusive equilibrium.

The isotopic composition of the C in the methane of these gases was found to be very light. It was shown that for coexisting CH_4-CO_2 pairs the carbon dioxide was always isotopically heavier.--Auth.

3-1608. Adams, John A.S., and K.A. Richardson. THORIUM, URANIUM, AND ZIRCONIUM CONCENTRATIONS IN BAUXITE: Econ. Geology, v. 55, no. 8, p. 1653-1675, 6 figs., 9 tables, Dec. 1960, 56 refs.

Twenty-nine samples of bauxites from different locations were analyzed for Th and U by gamma-ray spectrometric, alpha counting, and wet chemical methods. The Th concentrations range from 5.0 to 131 p.p.m. and average 48.9 p.p.m. The U concentrations range from 2.7 to 26.7 p.p.m. and average 11.4 p.p.m. The Th-to-U ratios range from 1.5 to 20.9, with an average value of 5.1. Zr determinations on some of the bauxites gave values ranging from 0.02 to 0.65% Zr, and averaging 0.09% Zr.

The Th, U, and Zr contents of the bauxites are related to the type of source rock. Bauxites derived from nepheline syenites contain more Th and U than bauxites derived from other rock types; bauxites derived from basic igneous rocks have the lowest Th and U concentrations, and bauxites derived from carbonate rocks have the lowest Th-to-U ratios. The greatest concentrations of Zr were found in bauxites derived from nepheline syenites, and bauxites derived from carbonates contained the lowest concentrations of Zr.

A study of samples from alumina plants treating Surinam and Arkansas bauxites shows that during the process, over 70% of the Th and U in these 2 bauxites is concentrated into the red mud, and the alumina contains very small amounts of these elements. This study also indicated that much of the Th and U in bauxites occurs in either primary or secondary resistate minerals.--Auth.

3-1609. Bell, Kenneth G. URANIUM AND OTHER TRACE ELEMENTS IN PETROLEUMS AND ROCK ASPHALTS: U.S. Geol. Survey, Prof. Paper 356-B, p. 45-65, 2 graphs, 3 tables (2 in pocket), 1960, 67 refs.

U is a minor trace-element constituent of petroleums and their natural derivatives. The quantity of U in crude oils produced by primary-recovery processes generally ranges from none to 5 parts per billion (p.p.b.) although some crude oils may contain as much as a few tens of parts per billion. The average U content for all crude oil is estimated to be about 1 p.p.b., or about 1/3 that of the average content of sea water. Paraffin-base crude oils have the smallest U content, less than 1 p.p.b. Mixed-base and asphalt-base crude oils, in general, contain a slightly greater quantity of U and show a rough positive correlation between specific gravity and U content. There is no correlation between U contents of crude oils and geologic ages of reservoir rocks. Crude oils from one region are no more uraniferous than those from any other, except perhaps as a result of local predominance of heavy aromatic and asphaltic constituents. As a group, the crude oils of the Colorado Plateau and Rocky Mountain regions, both being uraniferous provinces, contain less-than-average quantities of U, a condition that is attributed to predominance of paraffinic constituents. Crude oils produced by secondary-recovery processes utilizing water flooding and detergents apparently contain above-average quantities of U, possibly because they contain asphaltic residues that are removed from pore walls of reservoir rocks. The mode of occurrence of U in petroliferous materials and the source of the U have not been determined.

The bituminous constituents of rock asphalts contain as much as a few thousand parts per billion of U, the average being about 1,000 p.p.b., a concentration that is about a thousand-fold increase over that in crude oils and probably a somewhat smaller increase over that in petroleums. It is believed that the bitumens extract U from the host rocks. There seems to be a positive correlation between the U content of the bitumens and that of the host rocks.

There is no evidence that petroleum acts as an ore-forming fluid for U. Oil field waters containing dissolved organic substances extracted from petroleum, and hydrogen sulfide, may provide a reducing environment in which U brought in by ground water or hydrothermal solutions may be precipitated at the interface of the solutions.

Crude oil is not a practical source material for U; the total U content of the crude oil reserves of the United States does not exceed 5 tons. The bitumens of the rock-asphalt deposits of the United States contain several hundred tons of U, but, because these bitumens are dispersed in several billion tons of rock, they are not practical source materials for U. --Auth.

3-1610. Smirnov, A.I. **NEW DATA ON ELEMENTAL CONSTITUTION OF THE PHOSPHORITES IN THE KARATAU BASIN: Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in translation, v. 125, no. 1-6, p. 205-207, 4 figs., March-Apr. 1959, pub. 1960, 13 refs.**

Data from more than 250 chemical and 300 spectrographic analyses of phosphorites from the Karatau basin are presented. The elements which are concentrated relative to their average concentration in sedimentary rocks are the rock-forming elements P, F, and Ca, followed by microelements present as isomorphous admixtures in the primary phosphate. These elements include Sr, La, Y, Ce, Co, Pb, As, U, and Mo. B and Be are concentrated in some phosphorites by secondary processes. C, Mg, Si, Fe, and S are found in concentrations similar to, or somewhat lower than, their average in sedimentary rocks, and generally occur as constituents of the minor rock-forming minerals chalcedony, dolomite, calcite, gypsum, and pyrite. In lower concentrations than their average in sedimentary rocks are O, Ba, Mn, Cl, Li, and Sn. At present there are no data on H, Rb, Nd, Cs, Th, Se, Br, Pr, Sm, Dy, Gd, Tl, I or Eu.

During weathering the concentration of Mg, Ni, Co, Li, C, Cr, Ga, and Sr decreases, while Al, Si, P, and F increase somewhat. V, B, Zn, Ba, Mo, Be, Ti, Pb, and Ag increase markedly.

Significant variations in element distribution among the individual deposits were not observed, and weathering and metamorphism have made no major changes in the composition of the phosphorites.

The Karatau phosphorites are believed to have been precipitated in sea water of average elemental composition. Such differences in composition as occur in different deposits are assumed to reflect environmental conditions of deposition characteristic of the primary facies.--F. Manheim.

3-1611. Timofeev, G.I., and N.S. Ilina. **THE PROBLEM OF THE GEOCHEMICAL CONDITIONS OF SEDIMENTATION IN BAT-BAYOS TIME IN SOUTHERN DAGESTAN: Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in translation, v. 125, no. 1-6, p. 233-235, 4 graphs, table, March-Apr. 1959, pub. 1960, 6 refs.**

S, organic C, various forms of Fe and bitumen analyses were made on clays, sandstones, and siltstones from southern Dagestan. The amount of authigenic siderite found in the rocks ranged from .02% to .233%, while pyrite varied from negligible amounts to 1.4%. The pyrite content is correlated with organic matter concentration. Bitumen in the clays averaged .117%, while such bitumen as was found in the sands and siltstones is considered to have migrated in from the clays. It is concluded that Fe minerals and their paragenetic changes may indicate the capacity of the reducing processes in the sediments.--F. Manheim.

3-1612. Runge, E.C.A., and L. de Leon. **DISTRIBUTION OF MANGANESE IN A BIO-TOPO SEQUENCE OF SOUTHEASTERN IOWA SOILS: Iowa Acad. Sci., Proc., v. 67, p. 232-236, fig., 1960, 6 refs.**

Mn extractable by sodium hydrosulfite was determined for 9 soil profiles of a bio-topo (vegetation and drainage) sequence in southeastern Iowa. The distribution of Mn in the soils studied is influenced by vegetation, drainage, and pH. Under prairie vegetation the Mn is evenly distributed with depth in the well-drained soil, but with increasing wetness of the soil profile, Mn is apparently lost from the A_1 horizon and accumulates in the lower part of the B horizon. Mn accumulates in the A_1 and A_2 horizons of the well-drained soils developed under forest vegetation, but in profiles of increasing wetness the amount of Mn in the A_1 and A_2 horizons decreases and the amount of Mn in the lower B horizon increases. The distribution of Mn in the transition prairie-forest soils was intermediate between soils developed under prairie vegetation and those developed under forest vegetation.--Auth.

3-1613. Hanway, John J., and others. **EXCHANGEABLE POTASSIUM AND CLAY MINERALS IN SELECTED IOWA SOIL PROFILES: Iowa Acad. Sci., Proc., v. 67, p. 215-231, 4 figs., 2 tables, 1960, 6 refs.**

Exchangeable K values and X-ray diffraction patterns were obtained for soil samples from several modal profiles of 9 different soil series in Iowa. Exchangeable K in "moist" subsoils was consistently low and almost always lower than in the "moist" surface soil. Drying increased exchangeable K in all the soils, but the increase due to drying varied between soil series and with depth in the profile of each series. Reversion of exchangeable K to a nonexchangeable form on rewetting the oven-dry samples generally increased with depth in the profile but the exchangeable K never decreased to the original "moist" level. X-ray diffraction analyses showed the presence of montmorillonite, chlorite, illite and/or mica, and kaolinite in all the profiles, with mortmorillonite predominating. Vermiculite was present in some of the soil series. No relationship between the clay mineral content and the amount of exchangeable K could be established.--Auth.

3-1614. Brooks, F.A. TRACE AND MINOR ELEMENTS IN WOODBINE SUB-SURFACE WATERS OF THE EAST TEXAS BASIN: Geochim. et Cosmochim. Acta, v. 20, no. 3/4, p. 199-214, 12 figs., table, Nov. 1960, 2 refs.

As the first phase of an investigation of the possible geologic significance of the occurrence and distribution of trace and minor elements in deep subsurface waters, determinations have been made of these elements in a number of water samples from the Woodbine sand of Upper Cretaceous age in the E. Texas basin. The determinations were made by use of an emission spectrograph.

Of a number of elements which occur in trace amounts in Woodbine waters, 4 appear to vary systematically in concentration. Sr and K increase in concentration with increasing depth from which the water samples were produced. The distribution of Ba, which occurs in relatively high concentrations in the waters of the northwestern part of the basin, seems to be related to the pattern of deposition of nearshore sediments during a part of Woodbine time. The distribution of Mn, which is found in relatively high concentrations in the central portions of the basin, appears to reflect the areal extent of deeper parts of the basin. The occurrence of soluble Mn in this area indicates that reducing conditions have prevailed in the central part of the basin during the past.--Auth.

3-1615. Lanning, Francis C. CALCITE IN *LESQUERELLA OVALIFOLIA* TRICHOMES: Science, v. 133, no. 3450, p. 380, illus., Feb. 10, 1961, 9 refs.

By chemical analysis, trichomes of *Lesquerella ovalifolia* Rydb. have been shown to contain a high percentage of calcium carbonate. X-ray diffraction patterns showed that it was in the form of calcite. The calcite was inside the trichomes, and its depositional pattern conformed to the shape of the trichomes. A small amount of opal was present in the trichomes.--Auth.

3-1616. Jones, J.D., and J.R. Vallentyne. BIOGEOCHEMISTRY OF ORGANIC MATTER. I. POLYPEPTIDES AND AMINO ACIDS IN FOSSILS AND SEDIMENTS IN RELATION TO GEOTHERMOMETRY: Geochim. et Cosmochim. Acta, v. 21, no. 1/2, p. 1-34, 6 figs., 11 tables, Dec. 1960, 66 refs.

Quantitative data are presented on ninhydrin-reacting substances in hydrolysates and extracts of Recent sediments, sedimentary rocks, and fossils, as determined by column chromatography. The recovery of amino acids added in small amounts to a concentrated calcium chloride solution was found to be 94-96%, after precipitation of the Ca as calcium sulfate and removal of the HCl by vacuum distillation. Seventeen amino acids and 3 unknowns were detected in hydrolysates of surface and subsurface sediment samples, from Lake Opinicon, Ontario, with amino acids and other ninhydrin-reacting organic compounds accounting for nearly two-thirds of the soluble-N in the hydrolysate, and ammonia for most of the remaining third. Only 5 amino acids (aspartic acid, glutamic acid, alanine, leucine(s), and γ-aminobutyric acid) and one unidentified ninhydrin-reacting organic compound were present in a hydrolysate of shale from the Green River formation (Eocene). Amino acids accounted for only 0.014% of the total-N in the shale. It was calculated from the alanine content that the maximum temperature that the Green River shale could have been continuously subjected to during its history was 74°C. Amino acids were not detected in hydrolysates of 2 Precambrian sedimentary rocks, nor in a hydrolysate of a Miocene lignite. An acid extract of carnosaur "teeth" from the Upper Cretaceous contained leucine(s), ammonia, ethanolamine, and one unidentified ninhydrin-reacting substance that chromatographed similarly to an unknown found in a hydrolysate of laboratory heated *Mercenaria* shells.

Of the total-N in a shell of the univalve mollusc *Cassis Madagascarensis*, 50% was extractable with cold HCl, this fraction consisting of amino acids, ammonia and unidentified compounds, some of which reacted with ninhydrin. Only 57% of the N in a hydrolysate of the conchiolin-fraction of the shell was recovered in the form of amino acids and ammonia. Fifteen amino acids and 2 unknowns were detected in the hydrolysate of the conchiolin-fraction. The periostracum of a Pleistocene *Mercenaria mercenaria* shell liberated 16 amino acids and 3 unidentified ninhydrin-reacting substances on acid hydrolysis. The periostracum-free fossil shell had approximately the same amino acid composition as reported elsewhere for shells of living *Mercenaria*. Quantitative data on amino acids and other ninhydrin-reacting compounds were reported for samples of Pleistocene *Mercenaria* shells pyrolysed in the laboratory at 213 and 219°C. In the shell, alanine decomposed at a faster rate, and phenylalanine at an equal or slower rate, than the rates characteristic of the same amino acids in dilute aqueous solution. The N liberated from amino acids during pyrolysis could mostly be accounted for in the hydrolysates as acid-insoluble-N, ammonia, and soluble nitrogenous compounds, some of which reacted with ninhydrin. Amines were detected only in samples pyrolysed in sealed tubes.--Auth.

3-1617. Flesch, G.D., and others. THE ABSOLUTE ABUNDANCE OF THE CHROMIUM ISOTOPES IN CHROMITE: Geochim. et Cosmochim. Acta, v. 20, no. 3/4, p. 300-309, 7 tables, Nov. 1960, 11 refs.

Isotopic assays have been made on the Cr in 18 chromite samples from countries responsible for 81% of the chromite production between 1900 and 1950. The use of mixtures of separated isotopes to determine the accuracy indicates that the measurements are absolute. On the basis of these assays, the natural abundances of the Cr isotopes in atoms per cent are:

$$\begin{aligned} Cr^{50} &= 4.352 \pm 0.024, \\ Cr^{52} &= 83.764 \pm 0.036, \\ Cr^{53} &= 9.509 \pm 0.027, \\ Cr^{54} &= 2.375 \pm 0.018, \end{aligned}$$

where the limits cited represent 3σ. No variation in the isotopic composition of the Cr in any of the chromites examined was found within the stated limits.

The chemical atomic weight, computed on the basis of these abundance values and the latest accepted values for the masses of the involved isotopes, is 51.9985 ± 0.0013.--Auth.

3-1618. Cannon, R.S., Jr., and others. THE DATA OF LEAD ISOTOPE GEOLOGY RELATED TO PROBLEMS OF ORE GENESIS: Econ. Geology, v. 56, no. 1, p. 1-38, 19 figs., table, Jan.-Feb. 1961, 145 refs.

Searching questions about the origins of ore deposits have been asked for many years. Where do ore fluids originate - within the crust, or deeper? Can specific sources of ore metals be identified? When were ores deposited? How long did mineralization continue? What was the rate and paragenesis of deposition? Which deposits are cogenetic, and what metallogenetic provinces do they define?

Isotope analyses of Pb from rocks and ores provide a new tool for attacking such problems of ore genesis. About 2,000 such analyses now available from more than 20 laboratories have been compiled and studied for this purpose. The data now available suggest partial answers to some questions and serve to define other, new problems, not previously recognized. Their greatest import, however, is to illustrate the potential future significance of Pb-isotope studies.

Ore-Pb, as shown 2 decades ago, ranges widely in isotopic composition. Recent studies show that traces of Pb in ordinary rocks of the earth's crust exhibit apparently similar variations. All these variations are attributable primarily to mixing of old Pb with accumulations of new radiogenic Pb from decay of radioactive U and Th. Each sample of Pb preserves in its isotopic composition a record of its own mixing history: a composite record of the time this Pb was in different environments, its past associations with U and Th, and the geochemical processes that moved it from place to place.

Integrated study of all these variables will throw light on many difficult problems of ore genesis when adequate techniques are developed. Progress will be slow, however, until more accurate Pb-isotope analyses can be made at lower cost and more objective criteria developed for interpreting measured isotopic compositions in terms of geologic history.--Auth.

3-1619. Murthy, V. Rama, and Claire C. Patterson. LEAD ISOTOPES IN ORES AND ROCKS OF BUTTE, MONTANA: Econ. Geology, v. 56, no. 1, p. 59-67, fig., 2 tables, Jan.-Feb. 1961, 19 refs.

The isotopic compositions of leads in ores and rocks of Butte, Montana, suggest that the ore metals were neither late stage concentrates from the crystallizing magma that produced the Boulder batholith, nor concentrates of trace metals from nearby sedimentary rocks. The ore metals probably were concentrated and isolated in several non-shallow locations about 400 m. y. ago and were then transported into the batholith by the late stage fluids of the magma, after the batholith was emplaced 60 m. y. ago. Mixing of host rock Pb and ore mineral leads occurred in and near the ore zone.--Auth.

3-1620. Grunig, James K., and others. LEAD ISOTOPES IN ORES AND ROCKS OF BUTTE, MONTANA: Econ. Geology, v. 56, no. 1, p. 215-217, Jan.-Feb. 1961, 6 refs.

Discussion of a paper by Murthy and Patterson (see above). The isotopic composition of Pb of the Boulder batholith is based on the composition of Pb from quartz of one sample (S-1) and may not be representative of the whole quartz monzonite mass.

Rejection of feldspar Pb data by Murthy and Patterson because of supposed Pb contamination may be unwarranted. Slight cloudiness of the K feldspar is a primary or at most a deuteric feature.

If the batholithic model is not restricted to 2 dimensions but includes depth as well, the hypothesis of Murthy and Patterson need not necessarily depart from the classic hydrothermal epigenetic theory.--J. A. Chamberlain.

3-1621. Murthy, V. Rama, and Claire C. Patterson. LEAD ISOTOPES IN ORES AND ROCKS OF BUTTE, MONTANA: Econ. Geology, v. 56, no. 1, p. 217-218, Jan.-Feb. 1961.

Reply to a discussion (see above) by Grunig and others. Rejection of feldspar lead data is justified because feldspar probably had a genesis more complex than quartz. The most important information brought out by the data is that Butte ores were not related to associated igneous rocks by a simple differentiation process in one magma, this being a decided departure from classical concepts of hydrothermal genesis of Butte ores.--J. A. Chamberlain.

3-1622. Tupper, William M. SULFUR ISOTOPES AND THE ORIGIN OF THE SULFIDE DEPOSITS OF THE BATHURST-NEWCASTLE AREA OF NORTHERN NEW BRUNSWICK: Econ. Geology, v. 55, no. 8, p. 1676-1707, 8 figs., 27 tables, Dec. 1960, 33 refs.

The regional geology of the Bathurst-Newcastle area is briefly outlined. There are 2 types of sulfide deposits in the area: a) epigenetic fissure deposits, and b) massive sulfide deposits. Geological evidence can be variously interpreted to suggest a syngenetic, a source bed, or a magmatic hydrothermal origin for the massive sulfide deposits.

S^{32}/S^{34} ratios are presented for more than 300 sulfide samples from the host rocks and sulfide deposits. Four granite bodies are dated by the K-Ar method. Model Pb ages are presented for 5 galena samples.

Sulfides disseminated through the black shales and argillites of the host rocks are enriched in S^{32} (mean value 22.31) relative to the meteoritic ratio, and have a broad range of values.

S^{32}/S^{34} ratios for the sulfide deposits fall into 2 distinct groups. In general one group (21.88-22.05) represents the massive sulfide deposits, while the other group (22.18-22.21) represents the fissure deposits. This suggests 2 separate, but probably closely related sources for the S.

Granites intrusive into the host rocks of the sulfide deposits have a mean age of 386 ± 10 m.y. Pb minerals in the sulfide deposits have a mean model Pb age of 370 ± 20 m.y. Thus the Pb minerals and the granite bodies were emplaced during the same major orogenic event.

The sulfide deposits of the Bathurst area have a narrow range of S^{32}/S^{34} values. Sulfide deposits thought to have a magmatic hydrothermal origin all have a narrow range of S^{32}/S^{34} values. It therefore seems reasonable that well homogenized magmatic hydrothermal solutions are the most logical source for the sulfide deposits.

The homogeneity of the Pb isotope abundance data gives strong independent evidence that the ores are of a magmatic hydrothermal origin.

The problem of why the massive sulfide deposits are enriched in S^{34} is open for further investigation. --Auth.

3-1623. Wanless, Robert K., and others. SULFUR ISOTOPE INVESTIGATION OF THE GOLD-QUARTZ DEPOSITS OF THE YELLOWKNIFE DISTRICT: Econ. Geology, v. 55, no. 8, p. 1591-1621, 7 figs., 21 tables, Dec. 1960, 27 refs.

Sulfides in the ore bodies and their associated alteration haloes, the metamorphic facies of the greenstone belt, and the neighboring granodiorite have been examined in detail. Most of the samples investigated are slightly enriched in S^{34} with respect to the meteoritic standard. Although the over-all range is small (about 1.5%), significant variations were found between sulfides in the granodiorite and in the metamorphic facies of the greenstone belt. A direct correlation exists between the isotopic ratio and the distance from the granodiorite-greenstone contact; sulfides in the granodiorite are the most enriched in S^{34} whereas sulfides in the metamorphic facies contain progressively less S^{34} outward from the granodiorite contact.

Sulfides in early tension fractures are consistently lighter (i.e. they contain more S^{32}) than the sulfides in the surrounding greenstones, whereas sulfides in the later Au-quartz lenses are heavier than those in the associated alteration zones. In addition, profiles across the country rock, alteration zones, and Au-quartz lenses indicate that the heavy isotope has been preferentially retained in the alteration zones with the maximum enrichment in the ore. However, in the late cross-cutting quartz-carbonate lenses the lighter S isotope has been preferentially concentrated.

The isotopic studies indicate that the primary S isotopic distribution of the district was modified by granitization and metamorphism during which the S^{32} was mobilized to a greater extent, leaving the sulfides in the regions with the higher thermal histories enriched in S^{34}. The subsequent formation of the Au-quartz lenses was associated with intense chemical activity, and the S^{32} was again more mobile, resulting in an enrichment of S^{34} in the alteration zones and in the ore.--Auth.

3-1624. Sharp, Robert P., and others. OXYGEN-ISOTOPE RATIOS IN THE BLUE GLACIER, OLYMPIC MOUNTAINS, WASHINGTON, U.S.A.: Jour. Geophys. Research, v. 65, no. 12, p. 4043-4059, 7 figs., 7 tables, Dec. 1960, 16 refs.

The mean per mil deviation from a standard (average ocean water) in the O^{18}/O^{16} ratio of 291 specimens of ice, firn, snow, and rain from the Blue Glacier is -12.4; extremes are -8.6 and -19.2. This is consistent with the moist temperate climatological environment. The O^{18}/O^{16} ratio of snow decreases with declining temperature of precipitation, and it also decreases with increasing altitude at 0.5/100 m.

Analyses of the 3 principal types of ice, coarse-bubbly, coarse-clear, and fine, composing lower Blue Glacier, show that ratios for coarse-clear ice are generally lower and for fine ice they are mostly higher than the ratios for coarse-bubbly ice. This indicates that the fine ice represents masses of firn and snow recently incorporated into the glacier by filling of crevasses or by infolding in areas of severe deformation. Coarse-clear ice masses may represent fragments of coarse-bubbly ice within a breccia formed in the icefall. Because of unfavorable orientation, these fragments could have undergone exceptional recrystallization with reduction in air bubbles and, possibly, a relative decrease in O^{18}.

A longitudinal septum in the lower Blue Glacier is characterized by higher than normal O^{18}/O^{16} ratios. These values are consistent with an origin for this feature involving incorporation of much surficial snow and firn near the base of the icefall. Samples from longitudinal profiles on the ice tongue suggest that ice close to the snout comes from high parts of the accumulation area. Analyses from the light and dark bands of ogives are compatible with the concept that the dark bands represent greatly modified insets of firn-ice breccia filling icefall crevasses.

The range in ratios of materials is much greater in the accumulation area than in the ice tongue. This is attributed to homogenization, much of which takes place during the conversion of snow to glacier ice. This is supported by comparative analyses of snow layers when first deposited and months later after alteration. Refreezing of rain and meltwater percolating into underlying cold snow is an important mechanism as shown by analyses of ice layers and lenses in the firn formed in this manner.--Auth.

3-1625. Horibe, Yoshio, and Mituko Kobayakawa. DEUTERIUM ABUNDANCE OF NATURAL WATERS: Geochim. et Cosmochim. Acta, v. 20, no. 3/4, p. 273-283, 2 figs., 8 tables, Nov. 1960, 8 refs.

The deuterium abundance of natural water of various sources has been determined by the use of a deuterium mass spectrometer. The absolute deuterium contents of the reference sample nos. 1 and 1a of the U.S. National Bureau of Standards were found to be 0.0149 and 0.0128 mole % D_2O, respectively, by the comparison of the samples with the standard samples of known deuterium content. Relative enrichment of no. 1a to no. 1 $(R_{1a} - R_1)/R_1 \times 100$ was $14.13 + 0.23$, which agrees perfectly to the value reported by Craig. The variation of deuterium contents of tap waters of Tokyo and Osaka during last 2 years were within ± 1%, and any seasonal regularities could not be detected. Marine waters of the W. Pacific have almost the same deuterium content as those of the Pacific coast of the United States. Marine waters at various depths of the Antarctic showed relatively large variation of deuterium content (from +0.84 to −1.16% on the SMOW-scale), whereas the samples of Black Current of the Pacific showed little variation. It was found that the deuterium content of spring water suggests the origin of springs in some cases.--Auth.

8. MINERALOGY AND CRYSTALLOGRAPHY

See also: Sedimentary Petrology 3-1652, 3-1653; Mineral Deposits 3-1705, 3-1711, 3-1712.

3-1626. Bakakin, V.V., and N.V. Belov. THE CRYSTALLINE STRUCTURE OF HURLBUTITE: Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in translation, v. 125, no. 1-6, p. 343-344, table, March-Apr. 1959, pub. 1960, 8 refs.

X-ray and other studies have been made on hurlbutite in order to determine its relationship to danburite. It is concluded that hurlbutite differs from danburite chiefly in the Fedorov groups of the 2 minerals. A practical method of distinguishing the 2 minerals is the bluish-green luminescence of hurlbutite under X-ray and cathode-ray excitation, which does not appear in danburite. Spectrographic analyses of hurlbutite revealed traces of Si, Sr, Fe, Mn, Cr, Al, and Mg, in addition to the major elements P, Be, and Ca.--F. Manheim.

3-1627. Wiersema, Alice. EXPERIMENTS ON COLOR CENTERS IN CRESTMORE BLUE CALCITE: California, Univ., Radiation Lab., [Pub.] UCRL-9494, 33 p., 6 figs., 3 tables, Dec. 1960, 24 refs.

Color centers in blue calcite from the Crestmore region of California were studied by electron spin resonance. A spectrum of 4 equally spaced lines is obtained in addition to the spectrum of 30 lines due to Mn. This quartet extends over a range of about 30 gauss and is centered about a g value of 2.013. The spectrum of powdered calcite shows a variation of line width with magnetic field. By using the theory of McConnell - which relates the paramagnetic relaxation times, T_1 and T_2', the hyperfine interaction, and the correlation time, τ_c with the anisotropy of the g value - Δg is calculated as 0.002. From thermoluminescence studies of the blue calcite, 3 glow peaks are obtained, at 52°, 170°, and 262°C. The peak at 262°C. is obtained only with blue calcite. It occurs at the temperature at which the sample bleaches and is related to the color centers. Spectrochemical and quantitative chemical analyses were made to determine what impurities are responsible for the color centers. From consideration of the spectroscopic g value and the hyperfine splitting it is probable that the color centers are due to a cationic impurity with nuclear spin 3/2.--Auth.

3-1628. Kutina, J., and J. Sedláčková. THE ROLE OF REPLACEMENT IN THE ORIGIN OF SOME COCKADE TEXTURES: Econ. Geology, v. 56, no. 1, p. 149-176, 29 figs., Jan.-Feb. 1961, 21 refs.

The authors present evidence that cockade textures are not in all cases formed according to the hitherto accepted view, i.e. by successive deposition of minerals around rock fragments or fragments of vein filling. Three cases of cockade textures from Czechoslovak localities are described, in which layers forming fringes around rock fragments are younger than the mineral cementing them.

In the first of the 3 described cases, rock fragments are fringed by quartz and tetrahedrite (Polkanová, Slovakia), in the second case by quartz alone (Gelnica, Slovakia) and in the third case by sphalerite and quartz (Příbram, Bohemia). In all these cases the remaining space between the rock fragments is filled by siderite that originally represented the only cementing component. Later it was replaced by the above components in the direction away from the boundary with the rock fragments, giving rise to lining layers and thus to a texture called cockade. During the origin of the quartz band, a marked replacement of outer parts of the rock fragments also took place (especially in Polkanová and Gelnica).

In view of these results it is desirable to revise the the existing descriptions of cockade textures in the literature. It cannot be excluded that some of them may have been formed analogously as the textures described from Polkanová, Gelnica, and Příbram.

The present paper should at the same time contribute to the mechanism of formation of the so-called "segmented veinlets," known under this name from mineragraphic literature, as well as to the investigation of quartz metacrysts in siderite.--Auth.

3-1629. BIG PLATINUM NUGGET POSES DILEMMA FOR COLUMBIA: New York Times, v. 110, no. 37,660, p. 27, col. 5-7, p. 33, col. 3, illus., March 4, 1961.

A nugget of Pt as large as a large chicken egg was the gift of Czar Alexander II of Russia to Columbia University nearly a century ago. Valued at $1,800 for its metal content and at least $3,500 as a collectors item, the nugget cannot be put on public display for fear it would be stolen nor can it be given away because it was a gift. It is occasionally shown to classes in mineralogy.--M. Russell.

3-1630. Austin, S. Ralph. ILMENITE, MAGNETITE, AND FELDSPAR ALTERATION UNDER REDUCING CONDITIONS: Econ. Geology, v. 55, no. 8, p. 1758-1759, Dec. 1960, 7 refs.

Discussion of GeoScience Abstracts 2-2320. It is reaffirmed that acid reducing conditions favor alteration of ilmenite to titania. Post-depositional processes involving reducing conditions are as effective as weathering in altering ilmenite and perhaps magnetite and other Fe-Ti-bearing minerals as well as possibly feldspar. Thus the maturity of a sediment as indexed by the disappearance of these minerals can be produced by several processes.--J.A. Chamberlain.

3-1631. Hewett, D.F., and others. TEPHROITE IN CALIFORNIA MANGANESE DEPOSITS: Econ. Geology, v. 56, no. 1, p. 39-58, 5 illus., map, Jan.-Feb. 1961, 11 refs.

Recent studies of Mn deposits and mineral specimens in the Sierran belt of sedimentary rocks as well as in the Klamath Mountains to the N. and in the Rand Mountains to the S., have shown the presence of tephroite, the orthosilicate of Mn (Mn_2SiO_4), at numerous localities. Earlier studies of these deposits have shown that the original layered deposits of carbonate and hydrous silicates of Mn have been widely altered by metamorphism to spessartite ($Mn_3Al_2(SiO_4)_3$), rhodonite ($MnSiO_3$), and piedmontite ($Ca_2(Al, Mn''', Fe''')_3Si_3O_{12}(OH)$). Recent work shows that layered manganese oxides also were present in the original sedimentary rocks. It shows also that tephroite has formed widely in the original assemblage of carbonate, silicate, and oxide of Mn; in several localities, a little alleghanyite ($2Mn_2SiO_4 \cdot Mn(OH, F)_2$) has been formed. Rhodonite, spessartite, and piedmontite uniformly follow the tephroite; in places, bementite and neotocite are present. In one deposit a little pyroxmangite ($(Mn, Fe, Ca)SiO_3$) has been noted and in another, some crystals that are probably pyrophanite ($MnTiO_3$), not yet recorded in the United States.

By contrast, the restudy of large collections of material from deposits in sedimentary rocks of the Franciscan formation in the Coast Ranges indicates the tephroite is very uncommon; it has been recognized with assurance at only one locality - Alum Rock Park, Santa Clara County. In the Coast Ranges, rhodonite and spessartite, the high Mn garnet, are very uncommon. The assemblages of manganese silicates indicate that the layered deposits of Mn minerals in the Sierra belt have been metamorphosed to a higher degree than those of the Coast Ranges.

This review also shows the presence of axinite, the boro-silicate of Al, Ca, and Mn, in 3 deposits. --Auth.

3-1632. Chao, Edward C.T. COESITE FROM WABAR CRATER, NEAR AL HADIDA, ARABIA: Science, v. 133, no. 3456, p. 882-883, illus., March 24, 1961, approx. 5 refs.

The third natural occurrence of coesite, the high pressure polymorph of silica, is found at the Wabar meteorite crater, Arabia. The Wabar crater is about 300 ft. in diameter and about 40 ft. deep. It is the smallest of 3 craters where coesite has been found.--Auth.

3-1633. Overstreet, William C., and others. PSEUDOMORPHS OF KYANITE NEAR WINNSBORO, FAIRFIELD COUNTY, SOUTH CAROLINA: South Carolina, State Devel. Board, Div. Geology, Geol. Notes, v. 4, no. 5, p. 35-39, Sept.-Oct. 1960, 8 refs.

Kyanite in muscovite schist and quartzite is completely altered to muscovite pseudomorphs where the rocks occur as inclusions in, or are at the contacts of, a circular pluton of granite exposed to the W. and SW. of Winnsboro. Alteration of the kyanite to muscovite was accomplished at temperatures too high for chlorite or pyrophyllite to be formed and too low for sillimanite to form or kyanite to be preserved.--Auth.

3-1634. Sayanov, V.S. THE MINERALOGY OF CLAY MINERALS OF MIOCENE LIMESTONES OF THE NORTHWEST BLACK SEA REGION: Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in translation, v. 125, no. 1-6, p. 285-287, 2 maps, diag., March-Apr. 1959, pub. 1960, 5 refs.

Investigations of dispersed clay minerals in Miocene limestones of the NW. Black Sea region have shown that clay minerals are useful in facies correlation and as indicators of physicochemical sedimentation conditions.

Hydromicas predominate in the limestones and form a general background, on which other clay minerals have relatively limited distribution, frequently indicating the character of the source and deposition conditions. For example, kaolinite in the lower and middle Sarmatian is attributed to paleoriver supply from the Ukraine crystalline massif, known to be rich in kaolinite.--F. Manheim.

3-1635. Gorbunova, L.I. THE MINERALOGICAL COMPOSITION OF THE CLAYS OF THE LOWER CRETACEOUS DEPOSITS OF THE NORTHEASTERN CAUCASUS: Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in translation, v. 125, no. 1-6, p. 380-383, 6 illus., table, March-Apr. 1959, pub. 1960, 3 refs.

Lower Cretaceous clays from the northeastern Caucasus have been studied by microscopic, X-ray, chemical, electron-microscopic, thermal, and staining methods. The coarse pelitic fraction contains hydromicas, montmorillonoids, micas, quartz, feldspar, carbonaceous particles, spores and pollen, plant remains, heavy minerals, and the authigenic minerals calcite, glauconite, and pyrite. Three types of clays are distinguished, hydromica, beidellite, and mixed-layer. In the fine pelitic fraction montmorillonoids are enriched together with more highly hydrated hydromicas. Morphological features of the clays are illustrated.--F. Manheim.

3-1636. Zkhus, I.D., and G.P. Vagina. CLAY MINERALS OF THE MAIKOP FORMATION OF THE OZEK-SUAT REGION: Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in translation, v. 125, no. 1-6, p. 272-275, 3 figs. incl. illus., graph, table, March-Apr. 1959, pub. 1960, 11 refs.

Clay minerals of the [Tertiary?] Maykop deposits of Cis-Caucasia have been investigated by differential thermal analysis and staining techniques. The purpose of the investigation was to relate the clay mineral distribution to the supposed oil source rock character of the sediments. The main minerals found were hydromica and beidellite with subordinate kaolinite and montmorillonite. It is concluded that the preponderance of hydromica may be due to diagenetic alteration of montmorillonite to hydromica, and that the greater amounts of montmorillonite in Tertiary deposits may be due to the incompleteness of the alteration process.--F. Manheim.

9. IGNEOUS AND METAMORPHIC PETROLOGY

See also: Mineral Deposits 3-1713.

3-1637. Peterson, Donald W. DESCRIPTIVE MODAL CLASSIFICATION OF IGNEOUS ROCKS: Am. Geol. Inst., AGI Data Sheet 23, 4 p. in Geo-Times, v. 5, no. 6, p. 31-34, March 1961; also pub. separately.

The data sheets present a classification of the names most commonly applied to igneous rocks in a handy reference format. Data sheet 23a shows chiefly how the most common rock names are used and places them in a framework adaptable to use both in the field and in the laboratory. Data sheet 23b explains the use of the chart and its limitations and indicates a few common rock names whose definitions depend mainly on texture.--M. Russell.

3-1638. Woodcock, Alfred H. LAVA AND THE SEA: Oceanus, v. 6, no. 3, p. 12-13, 2 illus., March 1960.

Analyses of hygroscopic particles collected from haze over the Puna eruption of Hawaii would appear to confirm the theory that salt nuclei are introduced into the atmosphere from the contact of molten lava and sea water.--M. Russell.

3-1639. Gofshtein, I.D., and M.V. Ripun. A FIND OF VOLCANOGENOUS ROCK IN THE CRETA-

CEOUS SEDIMENTS OF PODOLIYA: Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in translation, v. 125, no. 1-6, p. 369-370, graph, table, March-Apr. 1959, pub. 1960, 7 refs.

Beds of bentonite regarded as having a volcanic origin were found in the Upper Cretaceous of the southwestern part of the Russian platform. Minerals in the beds include zircon, hornblende, acmite, biotite, tourmaline, rutile, chlorite, zoisite, garnet, dolomite, microcline and sanidine, as well as quartz, ilmenite, magnetite, and volcanic glass. The fraction under 0.001 mm. is almost entirely montmorillonite, as identified by X-ray and differential thermal studies. The source of the pyroclastic material is problematical. A chemical analysis of the clay is included.--F. Manheim.

3-1640. Shurkin, K.A. THE PALEOZOIC PSEUDOCONGLOMERATES OF NORTHERN KARELIA AND THE KOLA PENINSULA: Akad Nauk SSSR, Doklady, Earth Sci. Secs., in translation, v 125, no 1-6, p. 311-313, map, March-Apr. 1959, pub. 1960, 15 refs.

Studies on the Kandalaksha dike zone in northern Karelia and the Kola peninsula have shown that the Paleozoic pseudoconglomerates actually represent volcanic explosion pipes filled with broken rock fragments which have later been carbonatized. The new data lead to the conclusion that the Tury quartzite-sandstones formerly placed in the Tersky formation [Devonian] must be placed in the Jotnian formation [Eocambrian-Cambrian]. The discovery of a new explosion pipe in the NW. part of the area increases diamond prospects there.--F. Manheim.

3-1641. McCauley, John F. A PRELIMINARY REPORT ON THE GABBROS OF NEWBERRY COUNTY, SOUTH CAROLINA: South Carolina, State Devel. Board, Div. Geology, Geol. Notes, v. 4, no. 5, p. 41-43, map, Sept.-Oct. 1960, ref.

Initial reconnaissance work on the gabbro intrusives in the Newberry area indicates the presence of a roughly triangular plug, an irregular but generally arcuate plug, and a thin but remarkably continuous crescent-shaped dike. The arcuate and crescent-shaped bodies are probably ring dikes, whereas the triangular body represents a central plug emplaced at a higher level than the other two. These bodies are intrusive into the granodiorite and migmatitic gneiss of the Charlotte belt and are cut by diabase of Triassic(?) age. Although generally later than the metamorphic climax in the area they are also cut by pegmatites and extensively uralitized and saussuritized. If the pegmatites are not related to the mobilization of the wall rock during and after gabbro emplacement, it can be inferred that at least some acid magmatic activity postdated the emplacement of these basic intrusives.--Auth. concl.

3-1642. Pap, A.M. BASIC ROCKS OF THE CRYSTALLINE BASEMENT OF THE BELORUSSIAN-LITHUANIAN MASSIF: Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in translation, v. 125, no. 1-6, p. 387-389, table, March-Apr. 1959, pub. 1960, 4 refs.

Deep drilling in the Grodnensk district revealed dark-colored rocks of gabbro-dioritic composition. These rocks are regarded as the oldest magmatic formations known in the Belorussian-Lithuanian crystalline massif, and their age may be placed in the lower Archean stage of development of the tectono-magmatic mobile zone. It is also probable that the rocks penetrated in different boreholes are a single magmatic body conformable to the contours of magnetic anomalies in the area.--F. Manheim.

3-1643. Vedernikova, G.A. DIFFERENTIATED TRAPPEAN MASSIF OF THE PADUN RAPIDS ON THE ANGARA RIVER: Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in translation, v. 125, no. 1-6, p. 236-238, diag., table, March-Apr. 1959, pub. 1960, 12 refs.

Petrographic and chemical data are presented on the Padun massif. The massif is a diabasic sill varying in character from doleritic at the top to poikilo-ophitic at the bottom. Some contact metamorphism is found in the surrounding sedimentary country rock, and chemical modification of the sill itself due to influence of the sedimentary rocks was found.--F. Manheim.

3-1644. Martyanov, N.N. THE ORIGIN OF THE OVAL FORMS OF GRANITE PEGMATITES: Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in translation, v. 125, no. 1-6, p. 384-386, March-Apr. 1959, pub. 1960, 11 refs.

In studies of pegmatite bodies in the Sangilen highlands and the Yenesey ridge it was noted that layered and lamellar pegmatites were often crushed and fractured and were poor in pneumatolytic and rare metallic minerals such as muscovite, tourmaline, apatite and beryl. The ovoid pegmatite bodies were characterized by coarse, sometimes gigantocrystalline structures, pneumatolytic and rare-metal minerals, considerable replacement, and strong pneumatolysis of the host rocks. It is concluded that the oval bodies were cooled from pegmatite melts considerably enriched in mineralizing agents and had a lower viscosity and crystallization temperature. Under unstable tectonic conditions at depth such bodies may have undergone morphological development, while the volatile-poor lamellar bodies probably solidified before deformation of the walls of the fractures began.--F. Manheim.

3-1645. Kuman, V.E. SOME CHARACTERISTICS OF SODIUM METASOMATISM IN THE KRIVOI ROG BASIN: Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in translation, v. 125, no. 1-6, p. 345-347, 2 illus., graph, table, March-Apr. 1959, pub. 1960, 2 refs.

The region of Na metamorphism in the Krivoy Rog Fe ore basin is characterized by replacement of quartz, calcite, and magnetite by various sodium silicates, such as albite, alkali amphibole and cummingtonite. It is concluded that the solutions causing Na metasomatism were of hydrothermal origin, and that the Krivoy Rog basin remained a zone of tectonic weakness and pneumatolytic-hydrothermal activity for a long period of time in the Precambrian. --F. Manheim.

3-1646. Long, R.A., and others. AN EXAMINATION OF PARTS OF THE SOUTHERN COMPLEX NEAR PALMER, MARQUETTE COUNTY, MICHIGAN: Michigan Acad. Sci., Arts & Letters, Papers, v. 45, p. 119-124, map, 1960, 11 refs.

Mineralogic and petrographic details are given for Precambrian magmatic granite, quartzite of possibly volcanic origin, and a lit-par-lit injection gneiss mapped in selected small areas of the northern border of the Southern Complex, near Palmer, Michigan. The structural relations and lithologic similarities to other formations permits some speculations on the ages and stratigraphic positions of these rocks.--M. Russell.

10. SEDIMENTARY PETROLOGY

See also: Geomorphology 3-1434; Geochemistry 3-1611; Mineralogy 3-1630, 3-1634, 3-1635.

3-1647. Green, Jesse R. CONCRETIONS: Montana Acad. Sci., Proc., v. 19, p. 16-18, 5 illus., 1959, pub. 1960, ref.

The 3 basic forms of concretions are spherical, ellipsoidal, and cylindrical. The smallest forms are oölites of near microscopic size, the largest is over 100 ft. long. Concretions are crystalline growths with curved surfaces, in which the building molecules must have nonparallel sides like that of a wedge or cone. They usually occur in sedimentary rocks but are occasionally found in igneous rocks and biological systems.--M. Russell.

3-1648. Rosauer, E., and J. Frechen. CARBONATE CONCRETIONS IN THE KARLICHER LOESS PROFILE, RHEINLAND: Iowa Acad. Sci., Proc., v. 67, p. 346-356, 4 illus., profile, graph, 1960, 8 refs.

A loess profile near the town of Kärlich in the Rheinland of Western Germany contains various forms of carbonate which are described in detail. A systematic relationship concerning a transition from finely divided grains of carbonate to large complex concretions is given. The stratigraphic presence of 3 distinct zones of carbonate concretions and the results of analysis for carbonate content in the entire profile are presented as additional evidence for a ternary (and possibly a quaternary) climatic differentiation of the most recent glacial stage in the middle Rhein region.--Auth.

3-1649. Botvinkina, L.N. DIAGENETIC STRATIFICATION: Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in translation, v. 125, no. 1-6, p. 213-215, March-Apr. 1959, pub. 1960, 7 refs.

Diagenetic stratification is the result of 2 processes which take place at different times - formation of strata, and subsequently modification of the strata within the boundaries of the existing bedding planes. Examples are the lamination of lake oozes by oxidation of certain layers, replacement stratification such as secondary dolomite, stratification due to cementation and precipitation, and finally stratification by compaction.--F. Manheim.

3-1650. McLeod, Richard R. A THEORY FOR THE FORMATION OF LIMESTONE CAP ROCK OF SALT DOMES: Gulf Coast Assoc. Geol. Soc., Trans., v. 10, p. 151-153, 4 diags., 1960.

Osmosis, a new concept in subsurface fluid flow, is applied to the field around a shallow piercement type salt dome. In the process, ground water circulating under the influence of osmotic pressure deposits the limestone cap rock on the top of the dome. Limitations of the osmotic theory are discussed.--Auth.

3-1651. Bieber, C.L. PEBBLE COUNTS IN THE GLACIAL TILLS OF PARKE AND PUTNAM COUNTIES, INDIANA: Indiana Acad. Sci., Proc., v. 69, p. 210-213, map, 3 tables, 1959, pub. 1960, ref.

Pebbles in the tills of northern Putnam and E. Parke counties were probably derived from nearly the same sources. In southern Putnam County the till samples collected are so close to exposures of Pennsylvanian sandstone and shale, that percentages are locally affected. Over 30% of the till pebbles were not transported over 20 mi.; 25 to 30% traveled over 400 mi. Some 30% of the pebbles in the tills are Mississippian limestones and siltstones; nearly 30% are igneous and metamorphic; the balance are middle and lower Paleozoic age.--Auth. concl.

3-1652. Khalifa-Zade, Ch. M., and S. M. Abbasova. CHAMOISITE [SIC], CLAYS FROM KIMERIDGIAN DEPOSITS OF THE SOUTHEAST CAUCASUS: Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in translation, v. 125, no. 1-6, p. 377-379, graph, 3 tables, March-Apr. 1959, pub. 1960, 9 refs.

Sedimentological, X-ray, differential thermal, and chemical methods have been used to study chamosite-bearing rocks in the Kimmeridgian [Upper Jurassic] of SE. Caucasus. The hydromicas of the Kimmeridgian argillites were formed by the erosion and redeposition of Middle Jurassic clay rocks and were laid down in a shallow-water basin. The chamosite, however, is believed to have formed during diagenesis of the clay deposits. The small amount of organic C in the rocks indicates the existence of a neutral or weakly reducing depositional environment, while the alumina and silica which went into the chamosites are thought to have a volcanic origin. --F. Manheim.

3-1653. Lobanova, V.V. THE ROLE OF PYROCLASTIC MATERIAL IN THE FORMATION OF THE SALT STRATUM OF THE WEST AZGIR UPLIFT: Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in translation, v. 125, no. 1-6, p. 374-376, illus., diags., table, March-Apr. 1959, pub. 1960, ref.

The Permian salt stratum of W. Azgir in the southwestern part of the Caspian depression is an example of the formation of a halide basin with direct particcipation of pyroclastic material. This material has left a characteristic impression on the authigenic minerals of the salt stratum in the form of hillebrandite, barite, zeolites, and the rare borosilicate, sirlezite.--F. Manheim.

3-1654. Hiltrop, Carl L., and John Lemish. A METHOD FOR DETERMINING THE RELATIVE ABUNDANCE AND COMPOSITION OF CALCITE AND DOLOMITE IN CARBONATE ROCKS: Iowa Acad. Sci., Proc., v. 67, p. 237-245, 2 graphs, table, 1960, 17 refs.

The problem of determining the molar calcite to dolomite ratio in a carbonate rock arose as a result of investigations of concrete aggregate. A method for that determination is proposed, based on a combination of wet chemistry and X-ray techniques. Two carbonate rocks were analyzed, and calcite to dolomite ratios were determined, basing the computations on 2 different assumptions. Those results are compared and suggestions made for further work.--Auth.

3-1655. Snow, Brian, and others. **X-RAY DIFFRACTION STUDY OF INDIANA LIMESTONES: Indiana Acad. Sci., Proc., v. 69, p. 305-309, 3 graphs, table, 1959, pub. 1960, 7 refs.**

The objective of study was the determination of the relationships between the d-spacings and X-ray diffraction intensities of the characteristic peaks of dolomite and calcite and the composition of the Indiana limestones. The magnesium and calcium carbonate contents of Indiana limestone samples from more than 80 quarries were studied. A curve is derived showing the relationship between $MgCO_3$ content and intensity of the dolomite line at 2.89 Å which would give semiquantitative results for the $MgCO_3$ content of high-purity limestones.--M. Russell.

3-1656. Reshetnyak, N.D. **PSEUDOCLASTIC LOWER CARBONIFEROUS LIMESTONES ON THE SOUTHWESTERN MARGIN OF THE DONETS BASIN: Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in translation, v. 125, no. 1-6, p. 367-368, 4 illus., March-Apr. 1959, pub. 1960, 5 refs.**

Unusual pseudoclastic limestones with a porphyry-like structure were studied. The rocks are massive, gray or light-gray, have rather even bedding planes covered with minute knobs, a granular fracture, and thin clay partings. The limestones are traversed by many fractures containing brown oxide stains and dendrites. It is concluded that these structures are mainly due to syngenetic processes and to the diagenetic recrystallization of cryptocrystalline calcite. The fragments and nodules of cryptocrystalline calcite are often similar to coprolites described from the Moscow basin, but no proof of such an origin is available.--F. Manheim.

3-1657. Shepard, Francis P., and others, eds. **RECENT SEDIMENTS, NORTHWEST GULF OF MEXICO: 394 p., illus., maps, charts, secs., diags., graphs, tables, Tulsa, Oklahoma, American Association of Petroleum Geologists, 1960, approx. 500 refs.**

All but one of the papers that follow represent a symposium summarizing the results of work carried on in Project 51 of the American Petroleum Institute. This had as its objective during the period 1951-1958 the study of modern sediments along the NW. margin of the Gulf of Mexico. The paper by Grover E. Murray, on the other hand, was not part of the project but was contributed to give the geological setting for the area of investigation.

The NW. Gulf of Mexico was chosen by the A.P.I. research committee as the first area for investigation. The area is one which has been undergoing slow subsidence with accompanying sedimentation during much of geological history, and a large portion of the old sediments can be demonstrated to have accumulated in very much the same environments as exist today. The Mississippi delta provided an area of rapid, large-scale deposition. The continental shelf is unusually broad and has diverse current conditions. Large barriers extend along much of the coast. The bays vary from the highly saline Laguna Madre of the S. Texas coast to the low-salinity bays E. of Galveston, giving a wide range of conditions for sedimentation and ecology of the faunas.--From ed. pref.

Thirteen papers follow, abstracted separately below in the order in which they appear in the volume. The fourteenth paper, "Recent Sedimentology, Northwest Gulf of Mexico; Retrospect and Prospect," by Fred B. Phleger, p. 365-367, is unabstracted. It contains an attempt to place the activities and results of A.P.I. Project 51 work in their proper perspective.

3-1658. Murray, Grover E. **GEOLOGIC FRAMEWORK OF GULF COASTAL PROVINCE OF UNITED STATES (In: Shepard, Francis P., and others, eds. Recent Sediments, Northwest Gulf of Mexico: p. 5-33, 21 figs. incl. 15 maps, secs., 1960)**

The Gulf Coastal province of the United States is a segment of the Mesozoic-Cenozoic coastal geosyncline of eastern North America which can be traced continuously from Newfoundland to Guatemala. The geosyncline is roughly lens-shaped in cross section; approximately equal parts exist 1) submerged beneath the waters of the Atlantic Ocean and Gulf of Mexico, and 2) partly emerged adjacent to their shores.

The Gulf Coastal portion of the geosyncline has an area of more than 150,000 sq. mi. and contains about 50,000 ft. of predominantly arenaceous-argillaceous, marginal to shallow-marine strata, although calcareous materials predominate in the Florida peninsula and in the Cretaceous in Texas. The geosynclinal mass overlies Precambrian-Paleozoic rocks of variable facies, structure, and degree of metamorphism; their top surface possesses an over-all slope toward the Gulf of Mexico.

Strata of the Gulf geosyncline also possess a general gulfward slope, at least as far basinward as the edge of the continental slope, and thus constitute a great sedimentary structural arc from Florida to Mexico. Deformation from primary compressional movements is presently unknown. Instead, deformation appears to be principally a result of vertical movements due mainly to isostatic adjustments, density differences between a thick bed, or thick beds of salt and superjacent strata, and igneous emplacements. Larger structural anomalies, such as the Sabine and Monroe uplifts and the E. Texas embayment, constitute incipient growing "welts and furrows" in the developing geosynclinal province.

Axes of the larger anomalies trend primarily NW. and NE., but secondary N. and E. orientations also exist. Some evidence suggests that certain of these larger anomalies are, in fact, related to and probably positioned and controlled by Paleozoic structures and trends.

Major systems of normal, strike faulting, or of pronounced downflexing, believed to be associated with 1) downwarping of the margins of the Gulf of Mexico basin in the earlier stages of its development, and 2) subsidence related to rapid sedimentation, break the general continuity of the strata constituting the geosynclinal prism. The faults are of variable orientations; their dip ranges from 35° to 70°. Faults of younger, gulfward systems ordinarily dip more steeply than those of older, landward systems.

Pre-Cretaceous, Coahuilan, Comanchean, and early Gulfian rocks are predominantly red-bed clastics in the eastern and up-dip portions of the Gulf province of the United States; westward and down-dip marine equivalents of these beds predominate. Extensive marine deposits constitute the middle and late Gulfian, arenaceous facies predominating in the E. and argillaceous-calcareous materials being prevalent westward and down dip. Tertiary deltaic sediments center in Mississippi, Louisiana, and Texas; marine facies are prevalent eastward and down dip. Fluviatile and deltaic Quaternary deposits occur as a surficial mantle over much of the region; down dip they are replaced by marine equivalents.

Stratigraphic studies indicate that major sedimentary units are arranged in belts subparallel to the modern northern shoreline of the Gulf of Mexico. They have the general shape of flattened link sausages, the thicker lenses being centers or loci of deposition (depocenters) for a particular depositional epoch. Depocenters of the same age constitute a regional axis of deposition (depoaxis). Sedimentary materials have accumulated repeatedly in depocenters to thicknesses of 2,500 ft. or more, after which the depositional locale has shifted. Depocenters are not generally known to occur vertically above immediately older ones. Depoaxes have generally shifted gulfward from the Jurassic to the modern day; major reversals of this gulfward progression occurred in the Cretaceous and Tertiary and resulted in the formation of widespread cyclic depositional sequences (cyclothems).

During Jurassic and Cretaceous time the major source of sediments for the region was apparently eastern and central United States. In the Cenozoic appreciable quantities of material appear to have come from western United States.--Auth.

3-1659. van Andel, Tjeerd H. SOURCES AND DISPERSION OF HOLOCENE SEDIMENTS, NORTHERN GULF OF MEXICO (In: Shepard, Francis P., and others, eds. Recent Sediments, Northwest Gulf of Mexico: p. 34-55, 14 figs. incl. 10 maps, diag., 4 tables, 1960)

Principal sediment sources in the northern Gulf of Mexico are the Mississippi and Rio Grande basins, which supply subarkosic sands with highly unstable heavy mineral suites derived from mixed sedimentary, volcanic, plutonic, and metamorphic rocks. Components belonging to the last 3 groups predominate in the heavy mineral assemblages. Much of the detritus has been transported over very long distances. Tectonically, the source areas include both cratons and orogens. The distributive provinces are homogeneous, and sands, silts, and clays spread over the entire width of the shelf. The drainage basins of the rivers of western Louisiana, Texas, and the area E. of the Mississippi represent less abundant sediment sources. With the exception of the metamorphic and sedimentary suite of the Colorado River, sediments are orthoquartzitic with stable heavy mineral suites, and are derived from the Cretaceous and Tertiary margins of the Gulf Coast basin. Sands from these sources are distributed mainly in the nearshore zone, whereas the clays are carried by Gulf residual currents and deposited on the middle and outer shelf together with fine-grained Mississippi and Rio Grande material. The distribution patterns of the 2 major textural groups, sand and silt-clay, are virtually independent, and in many instances the sand, silt, and clay modes of the same locality have different sources. The sequence of nearshore environments produced by the Holocene transgression has resulted in the deposition of a complex pattern of sediments from a variety of sources.

Modification of the composition of the sand fraction by agents operating in the depositional basin appears to be of little significance except for the removal of pyroxenes by weathering from Mississippi and Rio Grande deposits exposed on the continental shelf during the Pleistocene.

A review of Gulf sediments in the light of theories on tectonic control of sediment properties leads to the conclusion that the tectofacies of the source and depositional areas has little influence on sediment composition in this area. Sediment texture is controlled almost exclusively by depositional environment, which is only to a small extent dependent upon tectonics. Consequently, in the Gulf of Mexico both textural and compositional properties of the sediments are to a large degree independent of tectofacies.--Auth.

3-1660. Shepard, Francis P. MISSISSIPPI DELTA: MARGINAL ENVIRONMENTS, SEDIMENTS, AND GROWTH (In: Shepard, Francis P., and others, eds. Recent Sediments, Northwest Gulf of Mexico: p. 56-81, 14 figs. incl. illus., 9 maps, diag., profile, graphs, 1960)

The study of more than 1,000 samples from the Mississippi Delta margins and from shallow borings made into the delta has provided some criteria for recognizing ancient delta facies. Almost all Mississippi Delta sediments are high in wood fibers, mica, and ferruginous aggregates.

It is suggested that this rapidly advancing delta includes the traditional top-set, fore-set, and bottom-set beds, although the depositional slope of the fore-set beds is almost everywhere less than 1°. The top-set beds are divided into subaerial and shallow marine. The subaerial include channel deposits, a mixture of sandy and clayey sediments with rare Foraminifera introduced by the salt wedge which penetrates the river mouth at low water; levee deposits consisting of laminated sands and silty clays; and marsh deposits which include peat beds and an abundance of rootlets along with layers of silty sand.

The shallow marine includes delta-front platform deposits which are commonly laminated and show rapid lateral and vertical changes from silty sand to silty clay, and interdistributary bay deposits which contain almost as much sand as the delta-front platform deposits and differ only in having somewhat thicker layers of clayey sediments and less lamination. The fore-set beds show a marked change from the platform deposits in having very little lamination and consisting almost entirely of poorly stratified silty clays. The fore-set beds resemble the top-set in having a scarcity of organic remains. The bottom-set beds are also silty clays, but they have a considerably greater percentage of Foraminifera, echinoids, and shell fragments than found in the other environments, evidently owing to slower deposition and higher productivity at a moderate distance beyond the river mouth. Mottling patterns due to reworking by organisms appear in the bottom-set beds and are found to an even greater degree in the more sandy deposits of Breton Sound.

Reworked delta deposits from which the fines have been removed are found in Breton Island and on the sea floor to the E., whereas a sandy old shelf deposit occurs farther E. and to the S. These old shelf deposits are being overlapped by the bottom-set beds of the modern delta.--Auth.

3-1661. Scruton, P. C. DELTA BUILDING AND THE DELTAIC SEQUENCE (In: Shepard, Francis P., and others, eds. Recent Sediments, Northwest Gulf of Mexico: p. 82-102, 17 figs., incl. maps, secs., profiles, 1960)

Study of the Mississippi Delta and several others shows order and pattern in delta building. The characteristic stratigraphic sequences form during a delta cycle which consists of constructional and destructional phases.

Marine deltas are seaward-thickening embankments of sediments deposited during the constructional phase and modified by the destructional phase. Sediments of the embankments are mostly land-derived clastics deposited in orderly sequence on the sea floor about distributary mouths. They make up the top-set, fore-set, and bottom-set beds of classical delta literature. Because of the way deltas grow, sediments change vertically in completed deltas in the same way they change seaward during construction; definite similarities between different deltaic sequences can be seen when they are compared.

Changing sediment properties are produced by seaward-changing depositional environments. Sedimentary environments of modern deltas, and ancient ones as well, are complicated when studied in detail, but the general relationships now are well known. The environments are defined by 1) sediment sources, 2) processes and their intensities, and 3) rates of deposition. Source areas determine the raw materials, and these differ from delta to delta. Similar marine and fluviatile processes, similar distributions of process intensity, and relatively high rates of deposition are the environmental properties that cause deltaic sequences to be similar. Relatively rapid deposition is the fundamental characteristic of deltas.

Deltas rarely build indefinitely in one direction; rather, the river shifts for a shorter route to the sea when it becomes over-elongated. The recently built delta is abandoned and modified by compaction coupled with marine wave and current action. This is the destructional phase, the time of winnowing of fine sediment and concentration of coarse material into thin veneers, beach ridges, and barrier islands.

Large alluvial plains at river mouths are built up in a step-by-step manner. Local delta construction is followed by partial destruction and later by another constructional phase. A large alluvial plain consists of several imbricating deltas, each lying partly on the toes of earlier deltas and partly on the surface that existed prior to any delta building. The stratigraphic components of younger deltas become seaward extensions of their older counterparts. When the beds are buried beneath still younger ones, their full history can be understood only by recognizing their deltaic origin and by knowing how deltas are built.--Auth.

3-1662. Thomas, William H., and Ernest G. Simmons. PHYTOPLANKTON PRODUCTION IN THE MISSISSIPPI DELTA (In: Shepard, Francis P., and others, eds. Recent Sediments, Northwest Gulf of Mexico: p. 103-116, map, 12 tables, 1960)

At 138 stations in the eastern Mississippi Delta area measurements were made of phytoplankton production ($C^{14}O_2$ uptake), chlorinity, temperature, supended solids, Secchi disc depth, inorganic phosphate, soluble silica, and soluble Kjeldahl N. In addition, the phytoplankton in the water were identified and enumerated. These stations were generally located inshore of those taken by G. A. Riley. The following results were obtained.

1) Surface phytoplankton production off the delta is equal to or greater than that of highly productive tropical or subtropical pelagic or neritic areas.

2) Surface production is quite variable; variation can be as much as seven-fold from one day to the next, at a given location.

3) Although seaward traverses made on single days showed that production generally increased at seaward locations, there were no over-all statistical differences between river, plume, and gulf areas at any given season.

4) During the period of high river discharge (May), surface production at the most seaward locations (gulf) was significantly greater than during the fall months. Phosphate and Kjeldahl N were also significantly greater in May than during the fall months in this area.

5) Integrated production in the water column was 3 to 6 times that occurring at the surface. Measured *in situ* water column production agreed within 20% with that calculated by Ryther's method in 3 out of 6 determinations. In the other determinations, the measured value was 3 to 6 times greater than the calculated value.

6) Rough calculations of the rate of sedimentation of organic C off the delta were compared with phytoplankton production. This comparison showed that it is unlikely that production contributes much organic C to pro-delta slope sediments. Production would have to proceed at the maximum rate throughout the year without losses of phytoplankton C to equal the rate at which C is deposited in these sediments. In the bottomset beds farther seaward we cannot estimate from the present data the relative contribution of organic matter by phytoplankton to these sediments.

7) Theoretical calculations indicate that N is a more likely limiting nutrient in these waters than phosphate. Silicate may limit phytoplankton only in highly saline water, where no silicate could be detected.

8) Two hundred species of phytoplankton were identified from the delta, of which 86% were diatoms. Two associations of primary species were recognized. One of these, consisting of species of *Cyclotella*, *Melosira*, and *Navicula*, was found in the river plume and Blind Bay. The other consisting of species of *Nitzschia*, *Thalassionema*, *Thalassiothrix*, *Skeletonema*, *Asterionella*, and *Chaetoceros*, was found in the gulf, plume, and Breton Sound. During any given season the relative concentrations of phytoplankton do not differ significantly from area to area. Significantly fewer phytoplankton were found in the river and plume at times of low water, but no significant difference in phytoplankton concentration in the gulf was found between May and the fall months.--Auth.

3-1663. Shepard, Francis P., and David G. Moore. BAYS OF CENTRAL TEXAS COAST (In: Shepard, Francis P., and others, eds. Recent Sediment Northwest Gulf of Mexico: p. 117-152, 27 figs. illus., maps, diags., graphs, 1960)

Approximately 1,000 samples have been obtained from the bays of the central Texas coast. Their size parameters, constituents, and organisms have been studied in relation to salinity, depth of water, and relations to entering rivers and to inlets. All of these bays are cut off from free connection with the gulf by barrier islands, although widely-spaced inlets allow some exchange with gulf waters.

Among the bay facies are 1) bays near stream mouths which have alternating silty clays and sands, commonly laminated and containing abundant plant fibers and aggregates, along with abundant ostracods in some localities; 2) shallow bays not related to stream mouths, which have an abundance of marine plants, a large number of gastropods, and higher sand content than most other bay environments; 3) deep central bays which have unstratified silty clay sediments commonly with a high content of benthonic Foraminifera in the coarse fraction; 4) central bays with oyster reefs which have been built up above the surrounding bay surfaces, and 5) bays near inlets or narrows where the currents have introduced considerable sand and the sediment is a bimodal sandy clay with relatively small silt content.

Borings into the bays and into the deltas recently built over their northern ends show that as much as 80 ft. of bay sediment has accumulated during the past 9,000 years, since the ocean first came up into the valleys eroded during glacial stages, in what is now the bay area. The samples from the borings along most of San Antonio Bay show a remarkable constancy of sediment types with the only significant changes being from central bay facies to oyster-reef facies. The faunas, however, indicate salinity changes. No lamination and little stratification were found in the borings except near or under the delta at the head of the bay.--Auth.

3-1664. Rusnak, Gene A. SEDIMENTS OF LAGUNA MADRE, TEXAS (In: Shepard, Francis P., and others, eds. Recent Sediments, Northwest Gulf of Mexico: p. 153-196, 30 figs. incl. illus., maps, graphs, 8 tables, 1960)

Laguna Madre is a linear coastal lagoon, developed on the pre-Holocene erosion surface by the buildup of a barrier island, resulting from the transgression brought about during the postglacial rise in sea level. The Holocene deposits average 10-20 ft. in thickness, although local depressions in the pre-Holocene surface may contain a considerably thicker section. The bulk of the Holocene deposits consists of subgraywacke and subarkosic sand. Local concentrations, however, include limestones, gravels, oölites, and relatively pure clays.

Source of the clay is unknown, but heavy and light mineral analyses of the sand fraction indicate locally reworked earlier deposits. The northern Laguna sediments are derived from the pre-Holocene sediments off the Nueces delta province, and the southern Laguna sediments are derived from the Holocene and pre-Holocene deposits of the Rio Grande distributary province.

The immediate source of the lagoonal fill is the barrier island sand, which is believed to be derived from the earlier deposits of the nearshore gulf. During and after sea-level rise, the nearshore gulf floor was actively eroded by wave action to establish an equilibrium profile. The eroded material was sorted, and the sand fraction was transported landward. Wind action piled the new beach sands into coastal dunes on the barrier. Where the earlier deposits were relatively unconsolidated, as offshore northern Padre Island, thick dune deposits could form because of large supply. Where the earlier deposits were more consolidated, and consequently less easily eroded, as in the vicinity of the Rio Grande delta, the dunes are lower and the barrier narrower.

Subsequent to the formation of the lagoon about 5,000 years ago, partial filling was accomplished by washover storm waves, wind transport, and tidal activity.--Auth.

3-1665. Shepard, Francis P. GULF COAST BARRIERS (In: Shepard, Francis P., and others, eds. Recent Sediments, Northwest Gulf of Mexico: p. 197-220, 16 figs. incl. illus., maps, charts, secs., profiles, 1960)

The barriers which skirt the greater part of the northern Gulf Coast constitute sand bodies with widths up to several miles and thicknesses of 20 to 60 ft. In most places the sand bodies are bordered on both sides by muddy sediments. The larger barriers have at least 4 facies - beaches, dune belts, barrier flats or marshes, and inlets. Each of these has sediment characteristics which are usually distinctive, one from the other. The beach sands can generally be separated from the dune sands by lower grain roundness, lower silt content, and more even stratification. The barrier flats and marshes have higher silt and clay content than the other environments and commonly contain calcareous aggregates. The inlets are intermediate in sand content and can be recognized by their mixture of bay and open-gulf organic remains. The barrier islands have formed either during or since the rise in sea level at the end of the last glacial epoch. Contrary to a long-held opinion, they are not related to coast lines of emergence but either to slow submergence or to a steady state. Accordingly, it is reasonable that the ancient barriers should have been preserved in the stratigraphic column of a subsiding area like the Gulf Coast.

The source of sand necessary to maintain the barriers is to a great extent the sand deposits of the continental shelf, supplemented by the sands of the few rivers which enter directly into the gulf rather than into bays. In places where the shelf sand has been covered by mud, the barriers have been known to be completely eroded. Some of the barriers are growing seaward and others have retreated, while still others have been quite stable in position during historical times.

Barriers are common along other coastal lowlands around the various continents, although they may develop to a moderate extent along mountainous coasts. They are particularly common along the flanks of the large deltas of the world, occurring especially at points where the delta deposition has temporarily ceased and where the area is subsiding and being reworked by the waves.--Auth.

3-1666. Curray, Joseph R. SEDIMENTS AND HISTORY OF HOLOCENE TRANSGRESSION, CONTINENTAL SHELF, NORTHWEST GULF OF MEXICO (In: Shepard, Francis P., and others, eds. Recent Sediments, Northwest Gulf of Mexico: p. 221-266, 19 figs. inc. illus., charts, graphs, 3 tables, 1960)

The continental shelf of the NW. Gulf of Mexico, between the Mexican border and the Mississippi Delta, is a smooth, gently sloping sediment-covered plain interrupted by occasional hills or banks. Many of these banks probably represent the surface expressions of salt domes protruding through the sediment cover. The width to the edge of the shelf at about 65 fathoms ranges from 50 to 130 mi. Drowned barriers relict from lowered sea level are found on the nondepositional part of the shelf.

The Holocene (Recent) sediments are divided into marine transgressive basal nearshore sands and shelf facies muds (silty clays and clayey silts). The basal sands are exposed at the surface near the shoreline and across almost the entire shelf off the Rio Grande, off E. Texas, and off westernmost Louisiana. The shelf facies overlies the basal facies off central Texas and off most of Louisiana. The thickness of the Holocene series is probably less than 20 ft. in much of the area where the basal facies has not yet been buried under the shelf facies, but is several hundred feet thick on the shelf in the vicinity of the Mississippi Delta.

Texturally about half of the surface sediments are polymodal mixtures of thin overlapping sediment masses deposited on the shelf during different periods of postglacial time. The mixing has been by burrowing organisms and the strong wave surges associated with hurricane waves, the former having produced irregularly interlayered and mottled sands and muds and the latter homogeneously mixed polymodal sediments. The sandy sediments are subarkoses everywhere, except off the central Texas coast where they are orthoquartzites. Some of the sediments contain mixed shallow and deeper shelf faunas. Most of the sand-size particles in the outer shelf silty clays are Foraminifera and fragments of echinoids. Glauconite is locally abundant in the relict basal sands of the outer shelf.

The sediments on the shelf are the products of the marine transgression following the Wisconsin glaciation. The chronology of this transgression has been traced back 17,000 years by radiocarbon dates of shells of nearshore organisms. The sequence of events has been interpreted in the light of textural and mineralogical characteristics of the sediments and from the physiography of the drowned barriers of the E. Texas shelf area. These ridges, which slope for long distances down the middle and inner shelf at acute angles to the contours, represent barrier spits deposited at the mouths of rivers during brief periods of regression. Two and possibly 3 periods of temporary regression interrupting the transgression are suggested. One of these, occurring at about the midpoint of the transgression, correlates well with the Two Creeks interstadial and the advance of the Mankato glaciers of North America. The wind pattern appears to have changed during these periods of regression and reversed the current directions in parts of the gulf.--Auth.

3-1667. Phleger, Fred B. SEDIMENTARY PATTERNS OF MICROFAUNAS IN NORTHERN GULF OF MEXICO (In: Shepard, Francis P., and others, eds. Recent Sediments, Northwest Gulf of Mexico: p. 267-301, 16 figs. incl. maps, charts, graph, 6 pls., 4 tables, 1960)

The planktonic foraminiferal fauna in the Gulf of Mexico is composed of mixed mid- and low-latitude species; the mid-latitude forms may be relict from the last glacial stage. Planktonic Foraminifera are characteristic of offshore water; they are rare on the inner continental shelf in this area; apparent depth zonation in the continental shelf sediments is due to frequency distributions. The Holocene planktonic assemblage is underlain by a mid-latitude assemblage of glacial age.

The benthonic faunas of the marginal marine environments, including marsh, lagoon, and beach, are delineated and are related to the known general characteristics of the environments. Distinctive faunas associated with deltas are fluvial marine, found in the Mississippi estuary, and deltaic marine or deltaic lagoonal. The best-known patterns of Foraminifera in the open ocean are associated with depth. Faunas of the following environments can be easily recognized - turbulent zone, 0-10 fathoms (0-18 m.); inner continental shelf, 0-30 fathoms (0-55 m.); outer continental shelf, 30-60 fathoms (55-110 m.): upper continental slope, 60-500 fathoms (110-910 m.); and lower continental slope and deep sea, deeper than 500 fathoms (910 m.).

It is not possible to evaluate single ecologic factors causing these patterns, but they can be discussed in general terms. Range of variation in the environmental features is an important general concept. Ecologically distinctive nearshore water masses are formed by varying amounts of runoff. The continental shelf in the Gulf of Mexico is overlain by the seasonal layer, the permanent thermocline water is on the upper continental slope, and the deep water is below 500 fathoms (910 m.).

Marginal marine biofacies of Ostracoda in the Rockport and Mississippi Delta areas have patterns similar to the foraminiferal biofacies.

Rates of deposition based upon live-total populations of Foraminifera correlate well with depth changes in the eastern Mississippi Delta. Low sedimentation rates are indicated for the lower portion of the Rockport area lagoons and high sedimentation rates for Mississippi Sound and Mobile Bay. The northeastern Gulf of Mexico continental shelf appears to be receiving little sediment; rates are high near the Mississippi Delta; and appreciable deposition is occurring only on the inner part of the NW. shelf.

The amount of Holocene sedimentation on the continental slope and in the deep sea is based on thickness of the beds containing modern planktonic foraminiferal fauna. In the NW. there is more than 150 cm. of Holocene sediment on the upper slope, with a decrease to about 100 cm. at depths greater than 1,000 fathoms (1,829 m.). In the central area few cores penetrated the modern fauna, and there is more than 200 cm. of Holocene sediment at depths less than 1,000 fathoms (1,829 m.), but sediment in the deep basin is not significantly thicker than that in the W. There is relatively thin Holocene sediment on the upper continental slope in the eastern sector; thicker deposits are found on the lower slope and basin.--Auth.

3-1668. Parker, Robert H. ECOLOGY AND DISTRIBUTIONAL PATTERNS OF MARINE MACRO-INVERTEBRATES, NORTHERN GULF OF MEXICO (In: Shepard, Francis P., and others, eds. Recent Sediments, Northwest Gulf of Mexico: p. 302-337, 17 figs. incl. maps, charts, graph, 6 pls., table, 1960)

The macro-invertebrate assemblages in the northern Gulf of Mexico can be separated into those occurring in the shallow lagoons and estuaries and those on the continental shelf and slope. Distributional patterns of faunal assemblages in lagoons and estuaries are considerably modified by prevailing climates. Climatic control is exerted to a lesser degree in the shallow waters on the continental shelf.

Eleven macrofaunal assemblages are recognized in the lagoons and estuaries along the northern coast of the Gulf of Mexico. Within each climatic zone certain of these assemblages are predominant, whereas others may be completely absent. Those assemblages which tolerate extended periods of low salinity, such as fresh-water marsh, river-influenced, and low-salinity oyster-reef assemblages, cover extensive areas in the humid zone. The number of species is small and populations are high in these environments. High-salinity assemblages characterize the semiarid zone, and here, also, large populations and a small number of species are typical. Within the subhumid zone, and its corresponding wide range of physical factors, most of the 11 macrofaunal assemblages are present. The extent of these assemblages in the subhumid zone is dependent entirely upon the prevailing climate at the time of sampling; during droughts, high salinity, open bay and sound assemblages predominate, and during wet periods, oyster reef and inter-reef assemblages are the most extensive.

Eight macrofaunal assemblages occur on the continental shelf and upper continental slope to 500 fathoms. Although 6 of these assemblages appear to be confined to rather narrow depth ranges, they are considerably modified by sediment type and average bottom-water temperature conditions. The general limits of the 6 level-bottom assemblages are 1) surf zone; 2) 2-12 fathoms, on the open coast; 3) 2-12 fathoms off the Mississippi Delta; 4) 12 to 30-40 fathoms; 5) 40-65 fathoms; and 6) 65-500 fathoms. One assemblage is restricted to rocky or calcareous bottom regardless of depth, and another consists of pelagic mollusks which indicate offshore surface waters.

Changes in climate and associated shallow-water environments are demonstrated for the Holocene transgression across the continental shelf of the northwestern Gulf of Mexico by using carbon-14-dated shells of species with restricted depth and environmental range, and temperature restrictive geographic ranges. At about 11,000 and again 9,000 years before present, the distribution of dated mollusk shells indicates that the climate along the now submerged shorelines changed from warm-temperate to subtropical and tropical. These conditions were synchronous with major circulation changes in the northern Gulf of Mexico as deduced from other evidence. The presence of extensive deposits of low salinity and surf-zone shells on the continental shelf also permits an interpretation of the location of large lagoons and estuaries and extensive stretches of barrier beaches during various periods of the Holocene transgression.--Auth.

3-1669. Shepard, Francis P. **RISE OF SEA LEVEL ALONG NORTHWEST GULF OF MEXICO** (In: Shepard, Francis P., and others, eds. Recent Sediments, Northwest Gulf of Mexico: p. 338-344, 4 figs., 1960)

Samples and borings on the continental shelf and in the bays along the Texas coast have provided relict nearshore and shallow-bay macro-organisms, allowing the dating of the Holocene (postglacial) rise of sea level along this relatively stable coast. The rise of sea level has been dated from 300 ft. below the present at 17,000 years before the present, to about 40 ft. at 8,000 years B.P. There is evidence suggesting that the rise has continued very slowly during most of the remaining period, but there is a possibility that the data are deceptive and that either the levels have fluctuated or the sea has been fairly constant for several thousand years.

Fluctuations during the 17,000-8,000 B.P. interval are indicated by eastward sloping drowned barriers that can be best explained as due to brief periods of regression produced by renewed growth of glaciers on the lands. These periods appear to correspond with some of the known readvances of the continental ice sheets.

The history of rise along the Texas coast appears to agree with that along other stable areas. On the other hand, the records obtained from the area around the Mississippi Delta appear to indicate an independent subsidence of that area of the order of about 1 ft. per century.--Auth.

3-1670. van Andel, Tjeerd H., and Joseph R. Curray. **REGIONAL ASPECTS OF MODERN SEDIMENTATION IN NORTHERN GULF OF MEXICO AND SIMILAR BASINS, AND PALEOGEOGRAPHIC SIGNIFICANCE** (In: Shepard, Francis P., and others, eds. Recent Sediments, Northwest Gulf of Mexico: p. 345-364, 10 figs. incl. maps, sec., diags., profiles, 3 tables, 1960)

This paper summarizes some of the results of recent sediment studies in the northern Gulf of Mexico and Orinoco area in terms of their interest for stratigraphy and paleogeography. The discussion is limited to modern sediments formed in a broad, open basin with a vast hinterland, an abundant supply of terrigenous sediment, and a general predominance of sedimentation over tectonic effects.

Studies of modern sediments are often based upon close observation grids, whereas in stratigraphy and paleogeography broad regional investigations using relatively open control are common. The importance of comparability in scale of comparative studies of ancient and modern sediments cannot be overemphasized. Many studies of recent sediments require generalization in terms of broad facies units and of descriptive features that are likely to be preserved, before they are suitable for use in the interpretation of ancient deposits. For the Gulf of Mexico a limited number of broad facies units can be established on the basis of simple and permanent lithologic, petrographic, and paleontologic criteria. Three of these are deltaic - the topset, foreset, and bottomset facies; 3, marginal nondeltaic - the littoral, subhumid, and semiarid bay facies; and 4, marine - the shelf, slope, marginal reef, and nondepositional facies. The same facies units can be used in describing geologically similar modern areas, for example, the Orinoco shelf. In simplified form, the geographic distribution of these facies is a function of the relative rates of sediment supply from the land and redispersion by marine agents. The series delta-subhumid bay and littoral-semiarid bay and littoral reflects decreasing importance of land-derived sediment and increasing marine reworking and dispersion. Where the supply of land-derived sediment is small, marine forces produce complete separation of the material in a coarse fraction deposited in the littoral zone and a fine fraction which is carried away in suspension. Where the current pattern supplies the suspended material and the water is deep and quiet enough to permit settling, the shelf facies is formed. Nondepositional areas occur where supply by marine currents is impossible (parts of the Gulf of Mexico), or long-period waves and shallow depth prevent deposition (Orinoco-Trinidad shelf).

Under conditions of changing sea level, the rate of positive or negative sea-level change is a factor of importance in controlling facies development. The effects of this factor are still poorly known. In areas of high supply of sediment its importance appears small; changes in the relative positions of sea and land in deltaic areas are primarily due to erosional transgressions and depositional regressions. On the other hand, where sediment supply is reduced, as in the area of nondeltaic marginal and shelf facies, eustatic and tectonic sea-level changes exert important control. The littoral facies is best developed under conditions of stable or very slowly rising sea level; the resulting bay facies is completely separated from the open-marine environment. With an intermediate transgression rate, open lagoons and low barriers are formed; with very rapidly rising sea level littoral sediments are deposited as a thin veneer without strong differentiation in bay and littoral facies. Little information is available concerning the influence of regressions. The stratigraphic sequence still appears the best means of distinguishing between transgressive and regressive deposits.--Auth.

11. GEOHYDROLOGY

See also: Sedimentary Petrology 3-1650; Engineering Geology 3-1737.

3-1671. Toksőz, Sadik, and Don Kirkham. GRAPHICAL SOLUTION AND INTERPRETATION OF A NEW DRAIN-SPACING FORMULA: Jour. Geophys. Research, v. 66, no. 2, p. 509-516, 2 figs., 3 tables, Feb. 1961, 6 refs.

A drain-spacing formula of Kirkham which is based on rigorous mathematical procedures and which has been tested in the field is now presented in graphical and tabulated form. The formula is useful for computing the removal of steady excess rainfall or steady excess irrigation water. A special case of the formula is compared with a formula derived by Hooghoudt for which he utilized the assumption of radial flow. Since Hooghoudt showed that his formula applied either to the removal of steady surface-applied recharge or to artesian water originating from an aquifer at great depth, we conclude that Kirkham's special formula applies also to surface recharge or to artesian water seeping upward from great depth.--Auth.

3-1672. Swartzendruber, Dale. WATER FLOW THROUGH A SOIL PROFILE AS AFFECTED BY THE LEAST PERMEABLE LAYER: Jour. Geophys. Research, v. 65, no. 12, p. 4037-4042, 4 figs., Dec. 1960, 6 refs.

Water movement through a water-saturated soil profile is analyzed on the basis of Darcy's law for a sectionally continuous hydraulic conductivity along a one-dimensional, downward flow path. The resulting relationships are used to assess the effect of the least permeable layer on the flow through the profile. It is shown that the hydraulic conductivity of the least permeable layer does not of itself control the flow.

A second analysis, based on a quantity defined as the hydraulic resistance, shows that the hydraulic resistance of the least permeable layer controls the flow through the profile with much less error than does the hydraulic conductivity. Furthermore, the error becomes negligible as the hydraulic resistance of the least permeable layer increases.--Auth.

3-1673. Youngs, E.G. THE DRAINAGE OF LIQUIDS FROM POROUS MATERIALS: Jour. Geophys. Research, v. 65, no. 12, p. 4025-4030, 3 figs., Dec. 1960, 7 refs.

An equation is derived to describe the yield of liquid at a given time from a freely draining column of initially saturated porous material in a gravitational field by using a capillary tube model. The equation is supported by experimental evidence.--Auth.

3-1674. Bear, Jacob, and David K. Todd. THE TRANSITION ZONE BETWEEN FRESH AND SALT WATERS IN COASTAL AQUIFERS: California, Univ., Water Resources Center, Contr. no. 29, 156 p., 49 figs., 10 tables, Sept. 1960, 40 refs.

The occurrence and structure of the transition zone between salt and fresh ground water in coastal aquifers were investigated theoretically and experimentally. The subject was treated both as a hydrological phenomenon and as a fundamental problem of dispersion caused by laminar flow in porous media.

A column analysis is presented for unidirectional and fluctuating velocity in porous media. It is shown that for the one-dimensional flow the final distribution depends on the total length of flow.

In the general case of a tracer point injection into a saturated isotropic media subjected to a sequence of uniform movements in various directions, the variance of the bivariate normal distribution which approximately defines the resulting concentration distribution is a second rank tensor. The concentration distribution across a transition zone, which develops when an abrupt interface between 2 miscible fluids is subjected to a sequence of such movements can be determined by integrating the result for a single point injection over the entire tracer region.

The property of isotropic porous media to disperse a tracer fluid is defined by the constant of dispersion which is shown to be a fourth rank tensor. Defining the displacement as a second rank tensor, the variance of the distribution is obtained as a product of twice the constant of dispersion and the displacement tensor.

The effect of tidal fluctuations on an initially abrupt interface in a coastal aquifer was studied by assuming that the aquifer is composed of a series of horizontal columns with fluctuating velocities. The result obtained was a transition zone which is wider near the coast and narrows further inland with approximately a normal distribution across it. A salt and water balance was set up for the transition zone, and the flow in the salt-water region was estimated. The effect of seasonal fluctuations in the water table on the transition zone was evaluated.

Experiments in a 4-in. lucite column packed with uniform sand were carried out to verify the theoretical results for fluctuating velocities. The concentration of the sodium chloride solution in the column was measured by means of a set of electrical conductivity probes inserted into the center of the column.

A second series of experiments to verify the theoretical results was carried out in a 2-dimensional Christiansen filter. Concentration measurements of a tracer dye were made by means of a photocell, the resistance of which changes with the intensity of light reaching it.--Auth.

3-1675. Hopkins, W.B., and T.A. Simpson. MONTANA EARTHQUAKES NOTED IN PENNSYLVANIA MINE-WATER POOLS: Am. Geophys. Union, Trans., v. 41, no. 3, p. 435-436, table, Sept. 1960, ref.

Most coal mines near Wilkes-Barre are idle, and ground water forms extensive pools interconnected by boreholes, tunnels, and other openings through the barrier pillars between mines. About 12 coal beds have been mined in this NE.-trending synclinorium. Continuous water-level recorders were in operation in 3 separate shafts at the time of the Montana earthquake of Aug. 18, 1959. As the traverse is only 0.5 in./hr. precise arrival of shock wave cannot be determined, and the weight of float and counterbalance dampen the recorded wave. The shock-wave approached at right angles to the structure causing a decrease in volume as a result of compressional stress and rise in water level, followed by a decrease owing to the removal of stress and a lowering of level. In the 3 shafts the maximum rise was .08 ft., .10 ft., and .03 ft., and maximum decline .05 ft., .07 ft., and .02 ft. respectively.--A.C. Mason.

3-1676. Lusczynski, Norman J., and Wolfgang V. Swarzenski. POSITION OF THE SALT-WATER BODY IN THE MAGOTHY(?) FORMATION IN THE CEDARHURST-WOODMERE AREA OF SOUTHWESTERN NASSAU COUNTY, LONG ISLAND, N.Y.: Econ. Geology, v. 55, no. 8, p. 1739-1750, 2 maps, sec., log, table, Dec. 1960, 2 refs.

The position and chloride concentration of a sizable body of salt water, moving slowly landward from the S.-shore bays of Long Island and the Atlantic Ocean were defined by recent test drilling in the Cedarhurst-Woodmere area of southwestern Nassau County, Long Island, New York. Most of the salt-water body is in the lower part of a permeable artesian aquifer; the lowermost part of the salt-water body is in clay deposits underlying the permeable aquifer.

The upper limit of the salt-water body in this area was found at depths increasing progressively in a landward direction. It was 318 ft. below sea level at a well in Cedarhurst and 541 ft. below sea level at a well in Woodmere. The lower limit of the salt-water body was determined at depths between 578 and 630 ft. below sea level in the Cedarhurst-Woodmere area. The salt-water body is more than 300-ft. thick at a well in Cedarhurst, and it thins out to zero in the vicinity of a pumping center about 1 3/4 mi. NE. of the Cedarhurst well.

Chloride concentration in the salt-water body in the Cedarhurst-Woodmere area ranged from about 40 to 16,000 p.p.m. (parts per million). Isochlors define a zone of diffusion about a mile wide in the Cedarhurst-Woodmere area. They indicate a thickness of diffused water ranging from a few tens to more than 150 ft. vertically.

Electrical-log data show that the upper boundary of the salt-water body moved upward 21 ft. between 1952 and 1958 at a site in Woodmere about half a mile SW. of the pumping center. From this information it is inferred that between 1952 and 1958 the leading edge of the salt-water front moved landward about 2,000 ft. toward the pumping center.--Auth.

3-1677. Osborne, F.L., Jr. BRINE PRODUCTION AND DISPOSAL ON THE LOWER WATERSHED OF CHAMBERS AND RICHLAND CREEKS, NAVARRO COUNTY, TEXAS. With a Section on the Quality of Water, by V.M. Shamburger, Jr.: Texas, Board Water Engineers, Bull. 6002, 66 p., 3 maps, sec., 2 graphs, 8 tables, March 1960, 8 refs.

The area of investigation is underlain by sedimentary rocks consisting of alternating beds of glauconitic sandstone and shale and a locally thin limestone, which belong to the Gulf Series of Cretaceous age, and the Midway group of Tertiary age which dip at approximately 115 ft. per mi. until interrupted by a graben in the center of the area. The principal brine-producing strata are the Woodbine formation, the Nacatoch formation of the Navarro group, the Wolfe City sand, Pecan Gap Chalk of the Taylor group, and the Pettet member of the Glen Rose formation. Approximately 88% of the total daily brine yield of 95,300 barrels is from the Woodbine formation - about 76% is produced from the Powell-Woodbine field alone. The remaining 12%, excepting 45 barrels from the Pettet member of the Glen Rose formation, is extracted from the shallower horizons.

Approximately 83,700 barrels of the total daily brine yield (95,300 barrels) is disposed of on the surface. Most of the brine drains directly to tributaries which flow into Chambers and Richland Creeks. The remaining 11,600 barrels is directed to the subsurface through injection wells partially for disposal but mainly to induce a stronger water drive to oil wells in order to facilitate production. The largest volume of brine disposed of to the surface occurs in the Powell-Woodbine field and is diverted to Crab and Cedar creeks at the rate of approximately 61,550 barrels per day.

Variations in the quality of water occur throughout the Corsicana area. Concentrations of total solids range from 3,800 to 30,000 p.p.m. in the Woodbine, to 34,790 to 39,727 p.p.m. in the Wolfe City sand. An analysis of produced brine from the Powell-Woodbine field, which contributes 76% of the total yield in the area, indicates concentrations of about 13,800 p.p.m. total solids and 7,400 p.p.m. chloride ion. This concentration represents 60 to 70% of the total calculated mineralization reaching the watershed. The chloride ion in formations stratigraphically above the Woodbine formation contributes 55 to 65% of the total dissolved solids concentration of the brine produced from those horizons.

A total average quality of brine received by the watersheds, inclusive of all contributing horizons, is computed to be 15,174 p.p.m. total solids and 8,245 p.p.m. chloride ion. Calculations based on on weighted average analyses show that approximately 223 and 121 tons per day of these constituents respectively reach the drainage.

The total amount of mineralization in the flow of Richland Creek at points below its confluence with Chambers Creek is derived from disposed oil field brines and the minerals in natural runoff on the watersheds. Calculations based on averages determined from flow measurements and analyses of samples at a point 5 mi. downstream from the confluence of the 2 streams indicate an average daily increment of minerals passing this point to be 1,049 tons of total solids and 275 tons of chloride ion of which increment approximately 827 tons of total solids and 154 tons of chloride ion were estimated to have been contributed by natural runoff. It is possible, however, that the runoff sampled under flood conditions prevailing in 1957 contained abnormal releases of impounded brines and mineralization from the leaching of brine-saturated soils in areas where surface disposal had been practised in the past.--Auth.

3-1678. Kortsenshtein, V.N. ON THE ZONE OF HELIUM-BEARING GROUND WATER IN THE JURASSIC STRATA OF THE CENTRAL CIS-CAUCASUS MONOCLINE: Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in translation, v. 125, no. 1-6, p. 339-342, map, table, March-Apr. 1959, pub. 1960, 6 refs.

Hydrochemical, geochemical, and hydrodynamic studies of Jurassic sections of the central Cis-Caucasian monocline have found that the strata contain large reservoirs of He. The waters associated with the He are highly mineralized and show characteristics of a stagnant regime. N makes up from 52 to 86% of the dissolved gases, carbon dioxide from 2 to 31%, hydrocarbons from 13-24%, and He from 1 to 1.6%. The original source of the He was not in Jurassic rocks but in the older rocks of the crystalline basement and in the metamorphosed Paleozoic strata.--F. Manheim.

3-1679. McGuinness, J. L., and others. **HYDROGEOLOGIC NATURE OF STREAMFLOW ON SMALL WATERSHEDS**: Am. Soc. Civil Engineers, Hydraulics Div., Jour., v. 87, no. HY1, pt. 1, p. 1-13, 5 figs. incl. map, 3 tables, Jan. 1961, 15 refs.

The importance of watershed area in depth-area-duration-frequency relationships on streamflow from small watersheds was investigated. Size of area was found to be an index of geologic and geomorphologic properties of the watersheds. Area index was related to annual streamflow and also to flows of as short as 2- or 8-day duration. A reconnaissance survey of base flow and a preliminary geologic investigation in one of the watersheds helped clarify the interrelationships between the geologic and hydrologic aspects of the study.--Auth.

3-1680. Hardt, William F., and others. **ANNUAL REPORT ON GROUND WATER IN ARIZONA, SPRING 1959 TO SPRING 1960**: Arizona, State Land Dept., Water Resources Rept. no. 7, 89 p., 22 figs., 3 tables, Sept. 1960, approx. 135 refs.

A summary of the basic hydrologic data collected from the spring of 1959 to the spring of 1960. The collection and analysis of basic data are integral parts of the investigation of the ground-water resources of Arizona, conducted by the U.S. Geological Survey in cooperation with the State Land Dept. About 3,000 water-level measurements were made during 1959 from all counties in the state. Most of the measurements were made in wells in the alluvial basins of southern Arizona where more than 80% of the population and 90% of the irrigated acreage are concentrated. The trend of water levels in the heavily pumped areas generally continued downward. Maximum declines occurred in the Salt River and lower Santa Cruz valleys and in the Willcox basin. Smaller declines of the water tables were measured in San Simon Valley and Douglas basin in Cochise County; McMullen Valley, Harquahala Plains, Gila Bend area, and Waterman Wash area in Maricopa County; and in Avra Valley and the Tucson basin in Pima County.

Water levels in the Duncan and Safford Valleys, San Pedro River valley, and upper Santa Cruz basin were about the same or slightly higher than in the previous year. Water levels continued to rise in the Yuma and Wellton-Mohawk areas. The northern half of the state had minor water-level fluctuations during 1959.

Pumpage of ground water in Arizona in 1959 was about 4,700,000 acre-ft., a slight increase in comparison to previous years. Development of ground water increased in McMullen Valley, Harquahala Plains, Willcox basin, and the Gila Bend area. More than 90% of the ground water used in Arizona is for irrigation, although the use of water for public supply has increased. More than 75% of the ground water pumped in Arizona is from the Salt River and lower Santa Cruz valleys. Pumpage has increased considerably since 1956 in the Willcox basin, mostly in the Kansas Settlement area. In northern Arizona, ground-water pumpage was minor - about the same as in previous years. Slight increases in pumpage were noted in Yavapai, Navajo, and Apache counties.

Illustrations include: 1) hydrographs showing water-level fluctuations for 10 years in selected wells; 2) maps showing change in water levels for the 5-year period spring 1955-1960 for the Salt River Valley, lower Santa Cruz, Willcox, and Douglas basins; and 3) figures showing surface-water storage and diversion, and mining of ground water in southern Arizona, and the quality of water from selected wells in the Tucson area. Also, included in this report is a complete list of unpublished and published reports on the ground-water resources of Arizona by the U.S. Geological Survey.--Auth.

3-1681. U.S. Geological Survey. **DATA ON WATER WELLS AND SPRINGS IN THE YUCCA VALLEY-TWENTYNINE PALMS AREA, SAN BERNARDINO AND RIVERSIDE COUNTIES, CALIFORNIA**: California, Dept. Water Resources, Bull. no. 91-2, 163 p., 2 maps (geol. map in pocket, scale 1:62,500), tables, June 1960, 8 refs.

This report, one of a series for the Mojave Desert region, tabulates all available data on wells and springs in the area from Yucca Valley to Twentynine Palms, 660 sq. mi. between 34°-34°37'N. 116°-116°30'W. It also shows reconnaissance geology, with special reference to the water-yielding deposits.

The area is one of interior drainage with no perennial streams. Principal landforms are broad alluvial fans and alluvial plains built out from the eastern slopes of the San Bernardino Mountains and northern slopes of the Little San Bernardino Mountains. Major water-bearing units are alluvial deposits which underlie the fans and fill local structural depressions to varying depths. Movement of ground water is impeded locally by barriers which are presumed to be major faults. These barriers separate the main valley areas into smaller ground-water basins. Displacement of ground water is mainly by infiltration of runoff from the mountains. A total of 516 wells and springs were inventoried in the area. Most of these are listed and are located on the map.--A. C. Sangree.

3-1682. U.S. Geological Survey. **DATA ON WATER WELLS IN THE EASTERN PART OF THE MIDDLE MOHAVE VALLEY AREA, SAN BERNARDINO COUNTY, CALIFORNIA**: California, Dept. Water Resources, Bull. 91-3, 223 p., 2 maps (in pocket) incl. geol. map, scale 1:62,500, tables, Aug. 1960, 14 refs.

This report, one of a series for the Mohave Desert region, tabulates all available data on wells in the Mojave Valley area from near Helendale to Barstow, 330 sq. mi. between 34°38'-35°N. 117°-117°30'W. It also shows reconnaissance geology, with special reference to the water-yielding deposits.

The area consists principally of broad alluvial fans and gently sloping alluvial plains built out from isolated mountains rising from the valley floor. Consolidated rocks include old crystalline, metamorphic, and sedimentary rocks of pre-Tertiary age, which form the basement complex, and Tertiary sedimentary rocks. These yield little or no water. Unconsolidated deposits include alluvium, fan deposits, and lacustrine deposits of Pleistocene age, and Recent alluvium, fan deposits, playa deposits, river-channel deposits, and dunes. Recent river alluvium is the principal water-bearing unit.

Movement of ground water through older alluvial deposits is complicated by several barriers, presumed to be major faults. Recharge to the area is from direct percolation of rain, from the Mojave

River, and subsurface ground-water flow from the W. part of the middle Mojave Valley area.--A. C. Sangree.

3-1683. U.S. Geological Survey. DATA ON WATER WELLS IN THE WILLOW SPRINGS, GLOSTER, AND CHAFFEE AREAS, KERN COUNTY, CALIFORNIA: California, Dept. Water Resources, Bull. no. 91-4, 85 p., 2 maps (geol. map in pocket, scale 1:62,500), tables, Sept. 1960, 6 refs.

This report, one of a series for the Mojave Desert region, tabulates all available data on wells in the 500 sq. mi. area between 34°52'-35°10'N. 117°57'-118°30'W. It also shows reconnaissance geology, with special reference to the water-yielding deposits.

The area includes one large ground-water subbasin NE. of Mojave, a relatively large subbasin N. of the Rosamond fault near Willow Springs, and several minor basins or subbasins in Antelope Valley. Both the Muroc fault and the Rosamond fault are well defined and are barriers to ground-water movement. Consolidated rocks include old crystalline, metamorphic, and sedimentary rocks of pre-Tertiary age, which form the basement complex, and Tertiary sedimentary and volcanic rocks. These yield little or no water. Unconsolidated deposits include Pleistocene alluvium and fan deposits and Recent alluvium, fan deposits, and dunes. Main aquifers are in the Pleistocene alluvium.--A. C. Sangree.

3-1684. Mason, Curtis C. GEOLOGY AND GROUND-WATER RESOURCES OF DIMMIT COUNTY, TEXAS: Texas, Board Water Engineers, Bull. 6003, 234 p., 10 figs., 13 pls., 11 tables, June 1960, 48 refs.

Dimmit County is on the Gulf Coastal Plain and has a maximum relief of about 470 ft. The county is drained largely by the Nueces River and its tributaries; the southwestern part is drained by tributaries of the Rio Grande. The rocks exposed consist chiefly of sand and clay and include the Kincaid formation of Paleocene age; the Indio formation, the Carrizo sand, the Mount Selman formation, and the Cook Mountain formation, all of Eocene age; the Uvalde gravel of Pliocene(?) age; the Leona formation of Pleistocene age; and Recent alluvium.

The Kincaid formation consists of dark fossiliferous marine shale, sandy shale, sandstone, and sandy limestone. The Kincaid does not yield water to wells in Dimmit County. The Indio formation consists of alternating layers of sand, shale, and clay, the finer grained materials being predominant. The Indio yields small supplies of water to a few wells in the county, but most of the water is highly mineralized. The Carrizo sand consists chiefly of fine- to coarse-grained sand and a few layers of clay. It is the principal aquifer in the county, supplying large quantities of water to wells throughout the county. The Mount Selman formation consists of sandy clay, clay, and a few thin beds of sand. The water is too highly mineralized for most uses, but a few ranch wells tap the formation in the eastern part of the county. The Cook Mountain formation consists chiefly of sandstone, interbedded with clay and a few lenses of limestone. The formation yields no water to wells in the county. The Uvalde gravel consists largely of chert gravel and silt. Capping the hills and divides, the Uvalde is not water-bearing in Dimmit County. The Leona formation and the alluvium consist of silt, sand, and gravel deposits occupying the stream terraces and valleys. They supply small quantities of water to a few wells in the county.

The dip of the Paleocene and Eocene formations toward the E. is slightly greater than the slope of the land surface, so that progressively younger beds are exposed from W. to E. The Uvalde gravel, Leona formation, and the alluvium form patches distributed sporadically across the beveled edges of the older rocks.

As the principal aquifer in the county, the Carrizo sand supplies more than 95% of the water pumped from wells. During the 1956-1957 irrigation season, about 24,200 acre-ft. of water was pumped from the Carrizo to irrigate 20,000 acres. The extensive irrigation has been in progress for many years and the large withdrawals of water have caused large declines in water levels throughout the county. Declines in the outcrop area have averaged 1.1 ft. per year during the period 1929-1957. In the artesian area, water levels have declined as much as 230 ft. in the same period. The average annual recharge to the Carrizo sand is estimated to be about 9,300 acre-ft. This is only about three-eighths of the quantity pumped during the 1956-1957 season.

The water in the Carrizo is generally suitable for irrigation in Dimmit County. However, a number of wells have been contaminated by salt water leaking into the Carrizo from the overlying Bigford member of the Mount Selman formation. The salt water has leaked through faulty casing or through old wells in which no casing was set opposite the Bigford. Contamination seems to be confined to individual wells with little likelihood of becoming widespread.--Auth.

3-1685. Baker, E.T. GEOLOGY AND GROUND-WATER RESOURCES OF GRAYSON COUNTY, TEXAS: Texas, Board Water Engineers, Bull. 6013, 152 p., 19 figs., geol. map, 10 tables, Sept. 1960, 21 refs.

Sedimentary rocks exposed at the surface in Grayson County [N.-central Texas near N. edge of Gulf Coastal Plain] are of Cretaceous and Quaternary age. Sand, clay, marl, and limestone of Cretaceous age, having a maximum thickness of about 3,600 ft., underlie the county, the beds dipping regionally to the SE. Quaternary alluvium mantles part of the surface along the Red River and occurs in scattered patches elsewhere in the county. The Trinity group and Woodbine formation of Cretaceous age are the principal water-bearing formations. Other stratigraphic units that yield water to wells are the Quaternary alluvium and the Pawpaw formation, Eagle Ford shale, and Austin chalk of Cretaceous age.

Ground water in Grayson County generally moves eastward and southward from areas of recharge to areas of discharge. Average rates of water movement in the Trinity group and Woodbine formation are estimated to be about 1.5 and 15 ft. per year, respectively. The chief source of recharge to these aquifers is precipitation on the outcrop, although Lake Texoma contributes some recharge to the Trinity where it crops out in the lake. Ground-water discharges naturally by evapotranspiration, by vertical leakage, through springs, artificially through wells, and by underflow out of the county to the SE.

The withdrawal of ground water in Grayson County in 1957 was about 5 million gallons per day. Of this amount about 61% came from the Woodbine formation, about 36% from the Trinity group and about 3% from the other water-bearing formations. Approximately 65% of the ground water pumped in Grayson County is withdrawn in the Sherman area. Increased withdrawal of water since World War II has resulted in a rapid decline of the water levels in parts of the county. The maximum decline in the Trinity group at Sherman from 1945 to 1958 was 113 ft., or about 8 ft. per year. During the same period water levels in the Woodbine formation at Sherman declined as much as 156 ft., an average of 12 ft. per year. Total declines since the early part of the 20th century were at least 180 ft. in the Trinity group and about 240 ft. in the Woodbine formation. Water levels in the area of outcrop of the principal aquifers, fluctuating chiefly in response to rainfall or changes in the natural rate of recharge, showed no appreciable decline from 1957 to 1959.

Coefficients of transmissibility, determined from pumping tests in Grayson County, averaged 2,800 g.p.d. (gallons per day) per ft. for the Trinity group and 3,200 g.p.d. per ft. for the Woodbine formation.

Results of chemical analyses of water samples indicate that the ground water in Grayson County is suitable for most purposes. The Trinity group generally yields soft water that is high in sodium-bicarbonate content and of questionable quality for irrigation. The water from the Woodbine formation ranges more widely in chemical composition than the water from the Trinity. It generally is soft but high in Fe content; it is usually suitable for irrigation in the outcrop area but unsuitable in the downdip area. Water from the other water-bearing formations, though generally hard, is suitable for most purposes, judging from the few analyses available.

The ground-water resources have been only partly developed. The volume of fresh water in transient storage in the Trinity group and Woodbine formation is estimated to be about 60 and 25 million acre-ft., respectively. Most of this water is not practicably recoverable because of the depth at which it occurs, but relatively high artesian heads and large available drawdowns in much of the county are favorable to future development within economic limits of pumping lift. In the Sherman area, however, concentrated pumping has caused large declines in the water levels, resulting in some dewatering of the Woodbine. Because of the large margin of safety before dewatering of the Trinity group begins, the Trinity is the most favorable source of additional ground water for Sherman. However, the higher lifting costs should be considered.

Large to moderate amounts of additional ground water can be obtained from the Trinity group and Woodbine formation in most presently undeveloped areas in the county. Water suitable for irrigation is available in moderate to large amounts from the Woodbine formation in places on its outcrop. A limiting factor to any major ground-water development, however, is the extent and thickness of saturated fresh-water sands available. The thickness of saturated fresh-water sand in the Trinity decreases northward; the thickness of the sands in the Woodbine is more erratic and has little definite pattern. Additional supplies of water may be available from the alluvium near the Red River, but more information is needed before definite conclusions can be reached.--Auth.

3-1686. DeCook, Kenneth J. GEOLOGY AND GROUND-WATER RESOURCES OF HAYS COUNTY, TEXAS: Texas, Board Water Engineers, Bull. 6004, 167 p., 10 figs., 7 pls. incl. 2 geol. maps, 8 tables, Aug. 1960, 41 refs.

The Edwards limestone of early Cretaceous age is the chief aquifer for San Marcos Springs and about 160 other springs and wells in Hays County, along the Balcones fault zone in S.-central Texas. Hays County is underlain by a basement of Paleozoic rocks, and in the southeastern part of the county the Hosston and Sligo formations of early Cretaceous age, correlative with the Coahuila series of Mexico, have been encountered in the subsurface. Rocks exposed in the county are principally Cretaceous and Quaternary sedimentary units, which are assigned to the Trinity, Fredericksburg, and Washita groups in the Comanche series; the Eagle Ford shale, Austin chalk, Taylor marl, and Navarro groups in the Gulf series; and the Leona formation and equivalent rocks in the Pleistocene series. Recent alluvium and colluvium locally overlie the older rocks.

In addition to the Edwards limestone in the Fredericksburg group, water-bearing rock units in Hays County include the Pearsall formation (Travis Peak of outcrop areas) and the Glen Rose limestone in the Trinity group, the Austin chalk and Taylor marl, and the Quaternary rocks.

The surface slope and regional dip are toward the SE. Several normal strike faults have displaced the Cretaceous rocks downward to the SE., the aggregate displacement being about 1,700 ft. within the county. The boundaries of the Edwards limestone ground-water reservoir are formed by major faults which are the major controls of movement of water.

Much of the water discharged at San Marcos Springs is derived from influent seepage from streams and infiltration from precipitation in recharge areas SW. of Hays County. The average underground inflow from Comal County through the Edwards limestone reservoir is estimated as 70,000 acre-ft. per year for the period 1934-1947. The discharge of San Marcos Springs, averaging about 55 million gallons a day during 1955, greatly exceeds local ground-water recharge within Hays County.

Depth to water, direction of movement of water, subsurface location of aquifers, and quality of water in Hays County have been determined from records of 519 wells and springs, drillers' logs of 49 wells, periodic water-level measurements in about 70 wells, and chemical analyses of water samples from 238 wells and springs.

Ground water from wells in the Pearsall formation generally contains less than 500 parts per million of dissolved solids. Water from the Glen Rose limestone in some places contains more than 500 p.p.m. of sulfate and more than 1,000 p.p.m. of dissolved solids; locally it is high in nitrate also. Water from the Edwards limestone commonly is very hard but is otherwise of good quality for most uses, except in the southeastern part of the county. Analyses of 2 water samples from the Austin chalk indicate a high content of bicarbonate. Water from the Taylor marl and from Quaternary sediments generally is hard, and locally it contains excessive nitrate.

Most wells in Hays County are used for domestic and stock supplies. About 20 wells, most of them in the Edwards limestone, yield water in relatively large amounts for industrial use, irrigation, or public supplies.--Auth.

3-1687. Anders, Robert B. GROUND-WATER GEOLOGY OF KARNES COUNTY, TEXAS: Texas, Board Water Engineers, Bull. 6007, 107 p., 15 figs., 4 pls. incl. geol. map, secs., 7 tables, July 1960, 34 refs.

The exposed rocks and those underlying Karnes County in S.-central Texas dip toward the Gulf of Mexico at average rates ranging from 20 to more than 200 ft. per mi. The oil fields in the county are on structures associated with faulting; the effect of faulting on the occurrence of ground water has not been determined.

The principal water-bearing formations underlying the county are, from oldest to youngest, the Carrizo sand, Yegua formation, Jackson group, Catahoula tuff, Oakville sandstone, and Lagarto clay. These formations range in age from Eocene to Miocene and are all of sedimentary origin. About 40 million acre-ft. of usable water (water containing less than 3,000 parts per million dissolved solids) is stored more than 2,500 ft. below land surface in the Carrizo sand; 30 million acre-ft. is stored in the younger formations at depths less than 1,000 ft.

Ground-water withdrawals for municipal, industrial, and domestic use averaged about 1.7 million gallons per day in 1957. Irrigation and stock supplies were derived from both ground- and surface-water sources. In general, water levels from 1936 through 1957 were not affected appreciably by withdrawals. Although recharge to the ground-water reservoir from precipitation represents only a small percentage of total precipitation, the rate of recharge exceeded the rate of ground-water withdrawal from wells in the county in 1957.

Most of the usable ground water in Karnes County is of substandard quality, whereas the San Antonio River water is of excellent quality although it is hard. Wells tapping the Carrizo may yield as much as 1,000 g.p.m. (gallons per minute) in the northwestern part of the county; wells in the shallower formations may yield as much as 600 g.p.m. in the most favorable areas, but in some places may yield only a few gallons a minute of water suitable only for stock.--Auth.

3-1688. Stearman, Jack, comp. WATER LEVELS IN OBSERVATION WELLS IN ATASCOSA AND FRIO COUNTIES, TEXAS, 1955-1960: Texas, Board Water Engineers, Bull. 6015, 10 p., 2 maps, 2 tables, graphs, Sept. 1960.

Contains records of water levels in 30 observation wells in Atascosa County and 21 observation wells in Frio County. Maps showing the location of the observation wells face the corresponding tables of water-level measurements. Hydrographs showing water levels in selected wells in the 2 counties follow the corresponding maps. Annual precipitation graphs for Poteet and Pearsall are combined with their respective hydrographs.

3-1689. Stearman, Jack, comp. WATER LEVELS IN OBSERVATION WELLS IN CAMERON, HIDALGO, AND STARR COUNTIES, TEXAS, 1950-1959: Texas, Board Water Engineers, Bull. 6008, 7 p., 3 maps, 3 tables, May 1960.

Contains water-level measurements made in 38 wells in Cameron County, 27 wells in Hidalgo County, and 43 wells in Starr County. An observation well location map faces the corresponding table of water-level measurements for each county.

3-1690. Stearman, Jack, comp. WATER-LEVEL MEASUREMENTS IN CULBERSON, HUDSPETH, AND JEFF DAVIS COUNTIES, TEXAS: Texas, Board Water Engineers, Bull. 6005, 7 p., 3 maps, 3 tables, Apr. 1960.

Contains water-level measurements made in 45 wells in Culberson County, 20 wells in Hudspeth County, and 8 wells in Jeff Davis County. With the exception of 1959, these measurements were made from 1955 through 1960. An observation well location map faces the corresponding table of water-level measurements for each county.

3-1691. Stearman, Jack, comp. WATER LEVELS IN OBSERVATION WELLS IN HASKELL AND KNOX COUNTIES, TEXAS, 1956-1960: Texas, Board Water Engineers, Bull. 6009, 10 p., 2 maps, graphs, 2 tables, June 1960.

Contains records of water levels measured in 28 observation wells in Haskell County and in 14 observation wells in Knox County. Maps showing the location of the observation wells face the corresponding tables of water-level measurements. Hydrographs showing water levels in selected wells in the 2 counties follow the corresponding maps. Annual precipitation graphs for Haskell and Munday are combined with their respective hydrographs.

3-1692. Stearman, Jack, comp. WATER LEVELS IN OBSERVATION WELLS, NORTHERN HIGH PLAINS, TEXAS, 1958-1960: Texas, Board Water Engineers, Bull. 6012, 17 p., 8 maps, 8 tables, Aug. 1960.

Contains water-level measurements made in observation wells in 8 counties. Changes in water levels from the winter of 1958-1959 to the winter of 1959-1960 are also shown in the tables. An observation well location map faces the corresponding table of water-level measurements for each county.

3-1693. Stearman, Jack, comp. WATER LEVELS IN OBSERVATION WELLS, SOUTHERN HIGH PLAINS, TEXAS, 1959 AND 1960: Texas, Board Water Engineers, Bull. 6011, 47 p., 23 maps, 23 tables, July 1960.

Contains water-level measurements made in observation wells in 23 counties. Changes in water levels from 1959 to 1960 are also shown in the tables. An observation well location map faces the corresponding table of water-level measurements for each county.

12. MINERAL DEPOSITS

See also: Areal and Regional Geology 3-1400; Geochemistry 3-1592, 3-1609, 3-1618 through 3-1623; Mineralogy 3-1628; Fuels 3-1729.

3-1694. McDivitt, James F. PROGRESS AND PROBLEMS IN THE SEARCH FOR ORE: Mineral Industries, v. 30, no. 3, p. 6-7, Dec. 1960.

Predictions of future consumption of mineral raw materials indicate a growing need which will necessitate greatly expanded reserves. The application of geophysics, geochemistry, and aerial photography to prospecting has greatly improved our reserve position. As the search for ore becomes more complex and costly, the pattern of exploration is changing. We see a trend towards scientific planning and coordinating of prospecting programs to assure optimum results at all stages. In many countries, where for one reason or another risk capital is not available, this coordinated program is set up through government exploration agencies. American companies are advanced in their practices but are hampered in setting up systematic prospecting programs by the antiquated system of locating mineral claims. There is little doubt that large mineral deposits remain to be discovered in many parts of the world. With the predicted surge in demand these deposits will soon be needed, and to make their discovery economically possible requires a coordinated program of research on the problems of mineral exploration on both the economic and the technological levels.--Auth.

3-1695. Hagen, John C. **DETERMINATION OF APPARENT ANGLES OF INCLINED LINEAR ELEMENTS: Econ. Geology, v. 56, no. 1, p. 204-209, 3 figs., Jan.-Feb. 1961, 2 refs.**

The apparent plunges of inclined drill holes and linear geological structures which perforate or approach a vertical cross-section obliquely should be shown accurately for correct data representation. Much time can be saved by using a graph or a slide-rule computer to determine the apparent angles of linear elements. The 2 mapping aids are based on the relationship $\tan \gamma = \tan\alpha/\cos \beta$ where α is the angle of plunge, β is the angle of convergence, and γ is the apparent inclination.--Auth.

3-1696. Winkler, Erhard M., and Barry Voight. **THE DETECTION OF RADIO-ACTIVE MINERALS WITH INFRARED AERIAL PHOTOGRAPHY: Econ. Geology, v. 56, no. 1, p. 211-212, Jan.-Feb. 1961, 4 refs.**

Pictures were taken of radioactive specimens in subdued light using infrared color film with a film-object distance of about 24 in. No radioactive effects could be observed. Similar negative results were obtained using a source of 5 mg. of Ra. This proves the inability of this film to reveal U ore bodies from the air either directly by bombardment of the film emulsion by radiation or by heat released during radioactive decomposition.--J.A. Chamberlain.

3-1697. Stringham, Bronson. **DIFFERENCES BETWEEN BARREN AND PRODUCTIVE INTRUSIVE PORPHYRY: Econ. Geology, v. 55, no. 8, p. 1622-1630, map, 2 tables, Dec. 1960, 17 refs.**

It has been statistically shown that a great majority of the larger Cretaceous and younger hydrothermal ore deposits of Au, Ag, Cu, Pb, Zn, Mo, Hg, and U in the Basin and Range province are associated with intermediate to acidic intrusive aphanitic or porphyritic rocks of near similar age. Recent work indicates that, except for the Pacific Coast Ranges and the Mother Lode area, similar ore-porphyry relationships apply to deposits over the entire western United States. However, many intrusive porphyries exist that have little or no associated hydrothermal deposits. Some intrusive porphyries, therefore, seem to be genetically related to ore deposits while others are not. These then may conveniently be classified into 2 categories as barren and productive.

To aid further the ore finder, an attempt is made here to offer criteria that will serve to distinguish barren from productive porphyries.

Among the many suggestive distinctions the following seem to be of most importance. Productive acid porphyry bodies generally are of considerable size and seem to cross cut enclosing rock structures with very little or no disturbance due to intrusive action. On the other hand barren porphyries may be of various sizes but on the whole have a tendency to either be concordant with wall rock structures or, where cross cutting relations exist, show obvious intrusive structural effects such as brecciation, folding, or up arching. Other criteria are tabulated in order of importance.--Auth.

3-1698. Cannon, Helen L. **BOTANICAL PROSPECTING FOR ORE DEPOSITS: Virginia Minerals, v. 7, no. 1, p. 1-11, 5 illus., 5 tables, Jan. 1961, approx. 80 refs.; reprinted from: Science, v. 132, no. 3427, p. 591-598, Sept. 2, 1961.**

Original article cited as GeoScience Abstracts 2-3532.

3-1699. Kogan, V.D. **THE GENESIS OF NATIVE SULFUR: Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in translation, p. 371-373, table, March-Apr. 1959, pub. 1960, 9 refs.**

The genesis of native S was studied by means of the accessory minerals present in the Gaudrak ores and associated rocks. A number of accessory minerals such as amphiboles, pyroxenes, quartz, plagioclase, tourmaline, garnet, etc. are enriched in both anhydrite and S ores but not in the limestones. It is concluded that the ores have been formed through replacement of gypsum and anhydrite. It is assumed that enrichment of gypsum and anhydrite with accessories is partly due to their accumulation closer to dry land than the limestones.--F. Manheim.

3-1700. Lovering, T.S. **SULFIDE ORES FORMED FROM SULFIDE-DEFICIENT SOLUTIONS: Econ. Geology, v. 56, no. 1, p. 68-99, 3 figs., 3 tables, Jan.-Feb. 1961, 42 refs.**

Assuming that many hydrothermal ore deposits are formed from emanations given off from a magma at depth while it cools through the interval in which latent heat of crystallization is generated, it is shown that this cooling interval for magmatic bodies of moderate size must be measured in tens or hundreds of thousands of years.

Emanations from such a magma should change at the source with time: relatively insoluble volatiles should depart early and the more soluble ones late; the general order is probably S gases and oxides of C, water, chlorides, and fluorides. Experimental and field evidence indicates that this order approximates the increasing solubility of these gases in natural magmas.

Theoretical considerations show that within a hydrothermal conduit a relatively small gradient would soon be established between the magma and the surface. A small gradient suggests that temperature drop is a minor factor in precipitating substances in solution, whereas a drop in pressure and reaction with wall rocks or with material precipitated from earlier emanations would be of major importance. The S-rich early emanations tend to react with indigenous Fe of the country rock, or with Fe carried by carbon dioxide-rich solutions to where a marked pressure drop occurs; either of these reactions will form abundant early iron sulfide. Later S-deficient emanations, which then carry soluble halides of ore metals, react with this early iron sulfide to precipitate the ore mineral sulfides by replacement and deposition with loss of Fe to the solution. Precipitation of much sulfide ore is thus commonly accomplished by S that was fixed near the site of the ore body by earlier emanations from the magmatic source; a large amount of ore, however, may be precipitated from late-stage magmatic solutions where they mingle with early-stage S-bearing solutions from a different magmatic source.--Auth.

3-1701. Hungsberg, Ulrich. ORIGEN DEL AZUFRE EN EL CASQUETE DE LOS DOMOS SALINOS. CUENCA SALINA DEL ISTMO DE TEHUANTEPEC [Origin of Sulfur in the Cap Rock of the Salt Domes of the Salt Basin of the Tehuantepec Isthmus]: Mexico, Consejo de Recursos Naturales no Renovables, Bol. 51, 96 p., 5 maps in pocket, tables, 1960, 46 refs.; text in Spanish.

A description of the general geology of the Isthmus salt basin is given based on the work of Benavides on "Geologia Petrolera de Mexico" [Petroleum Geology of Mexico], and a Jurassic-Triassic age is assigned to the salt deposits. These deposits originate from great thicknesses accumulated under very arid climatic conditions in a nearly enclosed basin isolated from the sea (Gulf of Mexico) by a very shallow ridge.

Various calcareous outcrops were studied, and representative samples were taken. Some salt samples were also collected. The calcareous samples were investigated to determine their mineralogical content, and it was concluded, given their attitude and composition, that they are an indication of outcropping salt dome cap rock, by a comparison of the samples with data on cap rock from the Louisiana and Texas salt domes. In addition, a study was made of the insoluble residue of the salt samples to determine their percentage and mineralogical composition. It was found that a large portion of these insoluble residues is quite similar to that of the salt domes of the U.S. Gulf Coast, and that 99% of the residues which were examined contained euhedral crystals of anhydrite, and the remainder, crystals of dolomite, quartz, gypsum, S, and oxides of Mn. This finding corroborates the theory that cap rock is formed by insoluble residues of salt.

A bacteriological study was also made of some cap rock samples that contained S; 2 types of bacteria of the genera Schmidlea and Lamprocystis were found. However, the samples may have been contaminated by exposure to the air for some time.

The theories proposed by various authors concerning the origin of S in the salt dome cap rock are reviewed in the last portion of the investigation. The theories are grouped into physicochemical theories and combined-physicobiochemical theories. According to the first group, it is supposed that the S formed from reduction of anhydrite $CaSO_4$ by various physicochemical agents. According to the other group, especially supported by Feely and Kulp, it is assumed that the reduction of $CaSO_4$ was brought to completion first by the action of sulfate-reducing bacteria (genus Desulfovibrio) and then proceeded physicochemically in a H_2S-saturated medium which reoxidized to S.--Auth., translated by D. Fisher.

3-1702. Hoekstra, Henry R., and Louis H. Fuchs. THE ORIGIN OF THUCHOLITE: Econ. Geology, v. 55, no. 8, p. 1716-1738, 6 figs., 7 tables, Dec. 1960, 30 refs.

The origin of the organic material, and the mechanism of formation of the organo-U complex, in thucholite from the Besner Mine, Parry Sound District, Ontario, have been investigated.

Results indicate that thucholite was formed by the action of aqueous solutions containing organic material, possibly as an oil-in-water emulsion. U, Pb, and other relatively soluble oxides were leached from uraninite while Al, Fe, Mg, and silica were deposited in the thucholite. The separation of U from Th and the rare earths is believed to have occurred by oxidation of tetravalent U to the more soluble hexavalent oxidation state. Oxidation of U and the organic fraction of thucholite in an otherwise reducing environment is assumed to be due to the action of radiation decomposition products of water, the hydroxyl radical and/or hydrogen peroxide. Oxidation of the organic material may also be due to subsequent reaction with hexavalent U. The liquid and solid hydrocarbons, by virtue of their optical activity, are shown to be of plant or animal origin, rather than polymerization products of methane and other low molecular weight gases. The hydrocarbons are probably not contemporaneous with the organic fraction of thucholite.--Auth.

3-1703. Joubin, Franc R. COMMENTS REGARDING THE BLIND RIVER (ALGOMA) URANIUM ORES AND THEIR ORIGIN: Econ. Geology, v. 55, no. 8, p. 1751-1756, Dec. 1960, 14 refs.

More is daily becoming known about the nature of the Algoma (Blind River, Ontario) U deposits and, accordingly, opinions on their origin may now be more meaningful.

In the first published description of the field following its discovery in 1952 the author then omitted reference to the possible origin of the ores but tacitly implied that they were probably hydrothermal and hypogene by identifying the field as centrally situated in a large metallogenetic province characterized by the classical hypogene mineral assemblage of Co-Ni-U. The author is now having second thoughts on the subject. Observations on new data and his opinions follow. The presently suggested theory does not mark the end of the road but rather another milestone.--Auth.

3-1704. Foley, Lyndon Lyman. GOLD AND SILVER IN MANGANESE ORE, POLK CO., ARKANSAS: Econ. Geology, v. 55, no. 8, p. 1757, Dec. 1960, 3 refs.

A sample of Mn ore from the Arkansas novaculite assayed 1.4% Cu, 0.02 oz./ton Au, and 0.67 oz./ton Ag. It is suggested that Au and Ag were leached from the country rock and transported with Mn to the site of deposition.--J. A. Chamberlain.

3-1705. Bradbury, James C. MINERALOGY AND THE QUESTION OF ZONING, NORTHWESTERN ILLINOIS ZINC-LEAD DISTRICT: Econ. Geology, v. 56, no. 1, p. 132-148, 5 figs., 3 tables, Jan.-Feb. 1961, 13 refs.

A detailed study of the mineralogy and paragenesis of the Zn-Pb ores of northwestern Illinois reveals that conditions of ore deposition were the same in the stratigraphically higher "crevice" deposits as they were in the deeper "flat-and-pitch" deposits. Except for an increase of galena relative to sphalerite in the crevice deposits, the minerals, their habits, and their relation to one another are the same in the 2 classes of deposits. In addition, spectrographic analyses show no differences in trace element content between samples of the same mineral from the different stratigraphic horizons.

It is proposed that the 2 classes of deposits do not represent zones of different conditions of deposition. Two possible causes of the increase of galena in the stratigraphically higher deposits are discussed.--Auth.

3-1706. Stam, J.C. **SOME ORE OCCURRENCES OF THE MISSISSIPPI VALLEY TYPE IN EQUATORIAL AFRICA: Econ. Geology, v. 55, no. 8, p. 1708-1715, 2 figs., table, Dec. 1960, 4 refs.**

An area in Equatorial Africa with ore occurrences of the Mississippi Valley type is described, and the characteristics of these occurrences are compared with those given by Ohle for deposits of this type in a previous paper [GeoScience Abstracts 1-2004]. Though important discoveries have not yet been made, a number of deposits have been developed and are presently being mined. Considering the fact that this type of deposit has yielded an important part of the world's Pb and Zn, it is certainly worthwhile to study further the potential possibilities of this region.--Auth. abs. & concl.

3-1707. Sterling, Philip J., and Charles G. Stone. **NICKEL OCCURRENCES IN SOAPSTONE DEPOSITS, SALINE COUNTY, ARKANSAS: Econ. Geology, v. 56, no. 1, p. 100-110, 5 figs., 2 tables, Jan.-Feb. 1961, 25 refs.**

Ni of possible economic interest has recently been found in an area 15 mi. W. of Little Rock in Saline County, Arkansas. The Ni occurs in sulfides in talc-carbonate rocks, in iron and manganese oxides in weathered serpentine dikes, and disseminated as sulfides in unweathered serpentine.

The dikes and the talc-carbonate rock occur in deposits that are currently being mined for soapstone. Assays of samples from the soapstone pits ranged from a trace to 15.0% Ni.--Auth.

3-1708. Stanley, Kirk W. **PLACER CASSITERITE OF THE "MANLEY TIN BELT," ALASKA: Econ. Geology, v. 56, no. 1, p. 213-214, Jan.-Feb. 1961, 3 refs.**

Cassiterite is a common accessory mineral in certain Au placer districts of Alaska. Optical studies of cassiterite indicate it is of detrital origin, derived from a concealed lode, not authigenic. Mineralogical associations suggest that the source area is a limestone contact deposit, a theory that should be taken into account in future exploration for primary cassiterite deposits in the area.--J. A. Chamberlain.

3-1709. Bracho Valle, Felipe. **YACIMIENTOS DE ESTAÑO EN LA SIERRA DE CHAPULTEPEC, ZAC., LA OCHOA, DGO. Y COSIO, AGS. [Tin Deposits of the Chapultepec Mountains, Zac., La Ochoa, Dgo., and Cosio, Ags.]: Mexico, Consejo de Recursos Naturales no Renovables, Bol. 48, 116 p., 79 illus. on 31 pls., 61 maps (6 in pocket), 6 tables, 1960; text in Spanish.**

The object of this study is to estimate the mineral reserves of Sn in the mountains of Chapultepec and Sombrerete at W. de Fresnillo, Zacaticas, the mining territory of La Ochoa, Durango, and the zone of Cosio, Aguascalientes.

The common genetic and geological characteristics are outlined for the deposits cited, although regional details are omitted as they do not constitute a distinguishable mineralogical mining entity. The deposits are grouped according to their location; the reserves are shown by means of comparative description.

The 2 mountain ranges are bounded on the E. by the Sain Alto valley; they are of high relief and are dissected by numerous torrential streams. On the NW., the ranges are linked with the mountain range of La Ochoa, Durango.

The limestones represent the oldest formations of the region. Miocene rhyolites define the area rich in Sn deposits. In the deposits of the Chapultepec mountains, the existence of rhyolite dikes is structurally defined. These dikes intersect the rhyolite effusive formations and the pyroclastics formed at the time of lava emission, and are characteristicly of the quartzitic and silicic rhyolite type. It has been determined that some of these rocks have appreciable Sn content, abundant magnetite, and also contain some pyrites and chalcopyrites. There are also deposits of the pyroclastic type, intercalated between the rhyolitic lavas which form enclosed and alternating horizons, with potential thickness of 2 to 25 cm. and fragments the size of a nut. The dike rock has been found to contain Sn as its primary constituent. It is probable that some rhyolite outcrops are actually dikes. The veinlets in the rhyolite joint planes are the most common type of deposits; they indicate mineralized belts of cassiterite. Mining veinlets at great depth is not feasible.

There are formations, similar to those previously described, which occur in groups of mineralized planes with potential thicknesses of less than 2 cm. and, in certain cases, on the order of millimeters. Generally there are 1 or 2 vertical planes that have greater thickness and from those, the mineralization extends along the planes of perpendicular and parallel jointing. Sn occurs in veins that can be identified easily with faulting fractures.

The exploited deposits of greatest economic importance are formations of pyroclastic breccias that contain Sn mineralization in their matrices. Invariably the Sn occurs as cassiterite. The estimate of reserves for the deposits investigated presents various problems in that the development of systematic sampling in order to evaluate the tonnages and content precisely is generally impossible. The lack of exposed minerals, the condition of the works, the narrowness of the veinlets, and the variability of the laws, render indefinite any calculation that is not based on a large number of samples. This is difficult to obtain given the above conditions.

Following the general statement, a few pages are devoted to the economic geological study of each of the mining zones included in this paper.--Auth., translated by D. Fisher.

3-1710. Campbell, Russell H., and Richard Q. Lewis. **DISTRIBUTION OF URANIUM ORE DEPOSITS IN THE ELK RIDGE AREA, SAN JUAN COUNTY, UTAH: Econ. Geology, v. 56, no. 1, p. 111-131, 4 figs., Jan.-Feb. 1961, 22 refs.**

The Elk Ridge area of southeastern Utah contains U ore deposits in 2 lower members of the Chinle formation of Late Triassic age. Each member is mineralized in different parts of the area, and where both are present only the lower contains ore. Across the Elk Ridge area from SW. to NE., successively younger beds lap onto the unconformity that separates the Chinle from the underlying Moenkopi formation of Triassic(?), Early and Middle(?) Triassic age. Important U deposits have been found only in sandstone beds of the Chinle that are in contact with the Moenkopi. Sandstone of the Chinle formation lies on the Moenkopi (or is separated from it by gray mudstone of the Chinle no thicker than the depths of most of the known paleostream channel scours) in 2 separate parts of the Elk Ridge area. These "favorable areas" contain all the mines and important prospects.

The ore deposits are flat-lying tabular to lenticular bodies in fluvial sandstone beds of the Chinle with fine-grained black U minerals chiefly interstitial to sand grains and as replacement of carbonaceous material. Most of the ore-bearing sandstone beds are discontinuous lenses intertonguing with and overlain by relatively impermeable mudstone. Contact of the host sandstone with the underlying Moenkopi seems to be a prerequisite for ore as the ore bodies are generally within a few feet of such contact areas, and sandstone lenses separated from the Moenkopi by gray mudstone are generally not ore bearing.

The consistent association of ore deposits with the Chinle-Moenkopi contact suggests that mineralizing solutions were introduced into the host beds from their areas of contact with the Moenkopi formation. Impermeable barriers overlying ore-bearing parts of the host sandstones were probably an important control on the deposition of ore minerals from solution. Hypofiltration of metallic constituents from ascending ore solutions may have been important. It is also possible that the overlying barriers formed traps for H_2S gas or fluid hydrocarbons and thus localized a reducing chemical environment in which ore minerals were later precipitated.--Auth.

3-1711. Anderson, Alfred L. **THORIUM MINERALIZATION IN THE LEMHI PASS AREA, LEMHI COUNTY, IDAHO:** Econ. Geology, v. 56, no. 1, p. 177-197, 10 figs., table, Jan.-Feb. 1961, 8 refs.

The Th mineralization in the Lemhi Pass area of southeastern Lemhi County, Idaho, is directed along simple to complex shear and fracture zones, and reopened Cu and Au-quartz veins and lodes, in impure quartzitic and phyllitic rocks of the Precambrian Belt series. Some of the shear and fracture zones are more than 40 ft. across and comprise broad zones of irregularly mineralized rock reaching distances to 2,000 ft. in length. These zones contain notable concentrations of Th and rare-earth elements along with considerable amounts of Ba, alkali metals, Ca, Fe, P, S, and Si and meager amounts of Nb, U, and perhaps other related elements. Minerals identified so far include thorite, allanite, monazite, xenotime (?), euxenite(?), apatite, specularite, barite, alkali feldspar, calcite, biotite, phlogopite, sericite, chalcedony, and quartz. The most characteristic minerals are the thorite, specularite, barite, and quartz. The specularite and Th-bearing minerals are intimately associated and were introduced into the deposits after the micas and in advance of the barite, feldspar, calcite, and quartz. Except for the specularite and quartz and in part the barite, feldspar, calcite, and thorite, the minerals are not distinguishable without the microscope.

Some of the deposits contain several percent thoria and comparable amounts of rare-earth oxides, but the average is generally under 1%. The area has an appreciable reserve of lode Th. Some of the deposits are in or are being brought into production.--Auth.

3-1712. Heinrich, E. Wm. **SOME RARE-EARTH MINERAL DEPOSITS IN MOHAVE COUNTY, ARIZONA:** Arizona Bur. Mines, Mineral Technology Ser. no. 51, Bull. no. 167 (Arizona, Univ., Bull. v. 31, no. 1), 22 p., illus., 5 tables, 1960, 7 refs.

Pegmatites in the Aquarius Range, Mohave County, Arizona, contain a variety of radioactive rare-earth minerals. Authenticated species are monazite, xenotime, euxenite, yttrotantalite, gadolinite, and allanite. Fergusonite also may be present. The occurrence of yttrotantalite, several tons of which have been produced, is the first that has been established for the United States. Within one pegmatite, the sequence of rare-earth minerals is accompanied by an increase in Y rare earths and Ta in younger minerals at the expense of Ce rare earths and Nb in older species. The variation in mineralogy among deposits shows that even in a relatively small area between apparently comagmatic dikes, Y earths may be combined in one case chiefly with O and SiO_2 (euxenite, yttrotantalite, and gadolinite), and in another mainly with PO_4 (xenotime) and that similarly, whereas one deposit will contain Ce earths chiefly as the phosphate (monazite), in another, Ce earths are combined mainly with SiO_2 to form allanite and to only a very minor extent with PO_4. In each of the pegmatites, the 2 subgroups of rare earths do not form minerals of the same chemical class, i.e., the phosphates xenotime and monazite are mutually exclusive as are the silicates gadolinite and allanite.

The identity of the abundant rare-earth mineral in the Kingman Feldspar pegmatite is established as allanite.--Auth. summ.

3-1713. Rose, Edward R. **IRON AND TITANIUM IN THE MORIN ANORTHOSITE, QUEBEC:** Canada, Geol. Survey, Paper 60-11, 12 p., geol. map (in pocket), scale 1 in. to 6 mi., 1960, 9 refs.

The Morin anorthosite is believed to be a composite intrusion, emplaced in several stages, accompanied by doming and deformation of the surrounding Grenville-type rocks. One of its main phases is a medium-grained gabbroic anorthosite that is intrusive in places into the anorthosite proper and apparently gradational elsewhere. Ilmenite and titaniferous magnetite deposits are associated with both types. Titaniferous magnetite deposits seem to be most closely related to the gabbroic anorthosite phase.

Titanomagnetite and ilmenite are important constituents of the titaniferous magnetite deposits, and ilmenite-hematite exsolution members are characteristic of the massive ilmenite deposits. In the Morin anorthosite the latter tend to produce weakly negative magnetic anomalies and the former strongly positive anomalies. Intergrowths of ilmenite and hematite and numerous other factors may scale down anomalies, from positive towards the negative. Thus the strength of the magnetic anomaly does not always indicate the grade or amount of iron-titanium oxide minerals present, but the anomalies serve as guides to relative concentrations of these minerals. Many of the strongly positive aeromagnetic anomalies in the Morin anorthosite body indicate the presence of large disseminated deposits in which titanomagnetite and ilmenite may be potentially valuable constituents as sources of Fe and Ti.--Auth. summ.

3-1714. McCauley, Camilla K. **EXPLORATION FOR HEAVY MINERALS ON HILTON HEAD ISLAND, S.C.:** South Carolina, State Devel. Board, Div. Geology, Bull. 26, 13 p., map (in pocket), 2 tables, 1960, 6 refs.

In 1954 and 1955 the U.S. Bureau of Mines and the National Lead Company made independent investigations to evaluate the deposits of heavy minerals on Hilton Head Island, one of the sea islands, in Beaufort County, South Carolina. The island is 12 1/4 mi. long and 5 1/4 mi. wide at its maximum width and has an area of 42 1/2 sq. mi.

The U.S. Bureau of Mines drilled 265 holes, of which only 17% disclosed a heavy mineral content of 3% or more. Analysis revealed an average heavy mineral content of 2.19% to a minable depth of 11.1 ft.

The National Lead Company drilled 545 holes. Of these, 20% had a heavy mineral content of 3% or more, based on an average minable depth of 10 ft. The average percentage of heavy minerals in the top 10 ft. was 2.14%.

Mineralogical analyses made by the U.S. Bureau of Mines on composite samples of heavy mineral concentrates revealed the following major components: ilmenite, 35.0%; zircon, 11.7%; rutile, 5.5%; and monazite, 1.43%.

It is estimated that there are at least 8,226,000 tons of heavy minerals on Hilton Head Island over an area of 18,000 highland acres. The richest deposits are along the northern half of the beach and adjacent foredune where the average heavy mineral content was 7.87%.--Auth.

3-1715. Ricketts, Carl E. **HEAVY MINERALS IN BLACK HILLS ALLUVIAL DEPOSITS: South Dakota Acad. Sci., Proc., v. 39, p. 41-47, 2 tables, 1960.**

This study was undertaken to determine the rare mineral content of Black Hills alluvial deposits.

Thirty-nine samples from 7 localities were studied and it was found that none of the deposits contained rare minerals in sufficient amount to make mining economically feasible.

Garnet was the most abundant mineral found in the investigation. Au and magnetite were also common. Small amounts of wolframite, scheelite, columbite-tantalite, and cassiterite were found in the Black Hills alluvial deposits.

Monazite and cinnabar, although reportedly present earlier, were not found in this paper. Likewise no rare earth minerals were found.--F.V. Steece.

3-1716. Colorado, Mineral Resources Board. **MINERAL RESOURCES OF COLORADO. FIRST SEQUEL. Prepared under the supervision of S.M. del Rio: 764 p., 68 figs. (2 in pocket), map (in pocket), 9 pls. (6 in pocket) incl. maps, tables, Golden, 1960, refs.**

The first comprehensive report on the minerals industry of Colorado, covering the years up to 1946, was published in 1947. This present volume is the first sequel in the series and deals with the years since 1946. In certain cases, such as petroleum, data not available in the 1940's is included here to cover the full range of time. Much basic data, however, both geological and generally informative, contained in the 1947 edition, are not repeated here.

In 4 parts. Pt. 1 contains an historical chapter on mineral development and chapters summarizing Colorado minerals production, 1946-1958, and mineral resources of the state, alphabetically by counties. Pt. 2, a special section on metals, deals with Mo, U, the rare earths, Th, Be, and minerals processing. Pt. 3 contains chapters on oil shale and coal, and Pt. 4 deals with petroleum and natural gas by regions of Colorado, with a final chapter on oil and gas conservation.--A.C. Sangree.

3-1717. Roby, R.N., and others. **MINES AND MINERAL DEPOSITS (EXCEPT FUELS), JEFFERSON COUNTY, MONTANA: Montana, Bur. Mines & Geology, Bull. 16, 122 p., 16 figs., map (in pocket), 35 tables, 1960, 56 refs.**

This bulletin outlines the geology, summarizes the metallic mineral production, and briefly describes the mining districts and many of the individual mines of Jefferson County.

The geology, for the most part, has been condensed from earlier writers supplemented by personal observations of the present authors. Production data are given in some detail. The majority of the individual properties herein described were idle and mostly inaccessible at the time of field examination, and consequently much of the information concerning them was summarized from older reports.

The principal rocks of the area are igneous rocks related to the Boulder batholith, which underlies most of the county. Some sedimentary rocks ranging in age from Precambrian (Beltian) to Tertiary are exposed in the southeastern part of the county. Ore deposits are related to the batholith, and at least 2 ages of ore deposition have been recognized.

The area has yielded mineral wealth to a value in excess of $100,000,000.--Auth.

3-1718. Karasik, M.A. **THE ASSOCIATION BETWEEN THE DIMENSIONS OF MINING FIELDS AND THEIR PRINCIPAL GEOCHEMICAL FEATURES: Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in translation, v. 125, no. 1-6, p. 299-301, table, March-Apr. 1959, pub. 1960, 13 refs.**

Contact metasomatic ore deposits in the Trans-Urals and Urals have been subdivided into 6 groups on the basis of 3 stages of mineralization: pre-skarn, skarn, and post-skarn.

The largest deposits are found in fields where mineralization is predominantly in the pre-skarn and skarn stages. The ores found include V-Ti-apatite Fe ores, Mn-specular ore, Co-sulfide ores and chalcopyrite and pyrite. Post-skarn ores show enrichment in sulfides but are relatively insignificant. The large mining fields are accompanied by larger pre-ore folding and fracturing disturbances and sharp contacts between the ore-containing rocks and the intrusives. The skarn stage is associated with Mn, while Mg, Ti, V, P, rare earths, Cl, and F generally accompany the post-skarn ores. The pre-skarn stage is often associated with scapolite-bearing rocks.--F. Manheim.

3-1719. Shcheglov, A.D. **THE CHIEF FEATURES OF THE METALLOGENESIS OF THE SOUTH PART OF WEST TRANSBAIKALIA: Akad. Nauk, SSSR, Doklady, Earth Sci. Secs., in translation, v. 125, no. 1-6, p. 269-271, March-Apr. 1959, pub. 1960.**

Caledonian and Hercynian folded zones may be clearly distinguished in the Transbaikal area and each is characterized by markedly different geological and metallogenic features. The Caledonian geosynclinal accumulations were enriched in carbonate material, with thick masses of limestones and dolomites. The subsequent metamorphic activity and intrusive development reflects the sedimentary environment through appearance of basic intrusives and skarns, and only subordinate occurrences of ores of Ti, Pb, Zn, and Au are found.

The geosynclinal stage of the Hercynian folded zone showed predominately noncarbonate, sand-shale flyschoid rocks, and the subsequent folded zone metamorphics are characterized by silicic and ultrasilicic granites. In contrast to the Caledonian folded zone, the development of the Hercynian folded zone is associated with the formation of numerous deposits of Sn, W, Mo, Au, fluorite, Sb, and Hg.--F. Manheim.

13. FUELS

See also: Geologic Maps 3-1390, 3-1391; Areal and Regional Geology 3-1413; Stratigraphy 3-1454; Paleontology 3-1535; Geophysics 3-1584; Geochemistry 3-1587; Mineralogy 3-1636; Engineering Geology 3-1736.

3-1720. Chepikov, K.P., and others. EPIGENETIC MINERALS AS INDICATORS OF THE TIME OF ENTRY OF PETROLEUM INTO COMMERCIAL SANDY RESERVOIRS: Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in translation, v. 125, no. 1-6, p. 288-289, March-Apr. 1959, pub. 1960.

The order of formation of epigenetic minerals in petroleum-bearing quartz sandstones from the Paishy series and the lower Carboniferous Mukhanov deposits was quartz-pyrite-carbonate (calcite and dolomite) - anhydrite. Carbonates and anhydrite are believed to form under conditions of fairly great depth and frequently replace quartz. It is shown that petroleum filled the pore spaces only after formation of all epigenetic minerals and therefore is younger. The entry of petroleum into the rocks brings all mineral-forming processes to a stop, while diagenetic processes can continue to operate in water-bearing rocks. The latter factor is reflected in higher intensity of formation of calcite and dolomite in the water-bearing strata than in the oil-bearing rocks.--F. Manheim.

3-1721. Rainwater, Edward H. STRATIGRAPHY AND ITS ROLE IN THE FUTURE EXPLORATION FOR OIL AND GAS IN THE GULF COAST: Gulf Coast Assoc. Geol. Soc., Trans., v. 10, p. 33-75, 33 figs. incl. illus., maps, secs., 4 tables, 1960, 108 refs.

The Gulf Coast of the United States is part of a large mediterranean sea area which has been in existence since Upper Jurassic. The many structural features within and adjacent to this basin which have profoundly influenced sedimentation are pointed out.

Some principles of stratigraphy which must be understood in order to decipher the geological history of this area are briefly revised and illustrated. The habitat of oil and gas, or the depositional conditions most favorable, less favorable, and least favorable for their occurrence, is described.

The need to make general studies in order to have a framework into which details can be fitted is pointed out, and criticism is aimed at several types of "research" which ignore known stratigraphic conditions.

Early stratigraphic studies which established the age and correlation and described the facies of Gulf Coast formations are briefly reviewed, as is also the part played in subsurface zonation by Foraminifera. The present status of stratigraphy and micropaleontology in petroleum exploration in this province is described.

The paper is mainly concerned with the application of stratigraphy in future exploration of the Gulf Coast. The Gulf basin history is outlined, and each of the major producing or potentially productive sections is described as to environment of deposition. The relationship of oil and gas occurrence to depositional conditions is pointed out for each section, and the exploration problems which stratigraphy can help solve are outlined. Generalized depositional-environment sections of the productive and nonproductive formations and small-scale dip sections showing depositional environment and structural position of the major stratigraphic units are presented.

From the amount of favorable facies of numerous stratigraphic sections in many areas yet to be explored, it is concluded that more oil and gas will be discovered in the future in the Gulf Coast than has been found to date, and that stratigraphy will play a leading role in this discovery.--Auth.

3-1722. Boriskie, Paul E. LAC BLANC FIELD, VERMILION PARISH, LOUISIANA: Gulf Coast Assoc. Geol. Soc., Trans., v. 10, p. 93-105, 8 maps, 2 secs., 1960, 2 refs.

The purpose of this study is to show the relationship between faulting, sedimentation, and accumulation of hydrocarbons as they occur in the Lac Blanc field. The Lac Blanc field is located in White Lake which occupies the SW. portion of Vermilion Parish, Louisiana. The structure of the field is that of a N.-S.-striking anticline which in turn is cut by a down-to-the-S. normal fault. Faulting in this area was contemporaneous with sedimentation as evidenced by thickening of sediments with depth on both sides of the fault.

Production comes from several sands which lie between the Discorbis bolivarensis and Siphonina davisi markers (lower Miocene) and are found on both the upthrown and downthrown sides of the fault. --Auth.

3-1723. Ferguson, Hershal C., Jr. THE TURTLE BAYOU-KENT BAYOU-NORTH TURTLE BAYOU COMPLEX: Gulf Coast Assoc. Geol. Soc., Trans., v. 10, p. 189-199, 8 figs. incl. maps, secs., log, 1960, 6 refs.

The Turtle Bayou-Kent Bayou-North Turtle Bayou complex, located about 65 mi. SW. of New Orleans in Terrebonne Parish, Louisiana, consists of 3 separate fields producing from middle Miocene strata. The producing structures appear to be 2 domelike features S. of a regional, E.-W.-trending, down-to-the-S. normal fault. As it enters the complex, the regional fault splinters into several separate faults, and on the N. side of each of the "splinters," a producing upthrown block is present. The closures developed on the regional fault "splinters" appear to be related to domal growth older than that accounting for the other 2 producing structures to the S.

Sand development throughout the middle Miocene is best in upper portions of this interval, for deeper in the section some sands lose the blanket characteristic found in shallower zones and instead exhibit a channellike configuration. The origin of deposition of any particular potential reservoir sand provides the limitations for the shape and extent of the bed and probably is a controlling factor in hydrocarbon accumulation.--Auth.

3-1724. Pine, Clyde A. STRATIGRAPHY AND STRUCTURE OF LAKE ARTHUR FIELD, JEFFER-

SON DAVIS PARISH, LOUISIANA: Gulf Coast Assoc. Geol. Soc., Trans., v. 10, p. 243-257, 11 pls. incl. maps, secs., log, table, 1960, 8 refs.

Lake Arthur field is located in T. 10 S. and R. 4 W., Jefferson Davis Parish, Louisiana, just N. of the city of Lake Arthur. This field was discovered as a result of the drilling of the Joe Sturdivant #1 by the Shell Oil Company in 1937. Principal development of the field took place during World War II and immediately thereafter. The discovery of the "Main Camerina sand" in 1953 initiated the greatest drilling activity in the history of the field, and it became the most important producing sand.

The sediments encountered by wells drilled in the field are all Cenozoic in age, ranging from Recent to Miocene.

Subsurface studies of the field show it to be a deep-seated domal structure, fractured by many normal, down-to-the-basin faults, the complexity of which increases with depth.

A combination of the domal uplift and the complex fault patterns forms structural traps for petroleum. Much of the production is from beds on the downthrown side of the faults, where the sands are thicker because of rapid deposition of sediments contemporaneous with faulting. The primary example of this is the "Main Camerina sand."--Auth.

3-1725. Shirley, Jack W. STRUCTURE AND STRATIGRAPHY OF RAYNE FIELD: Gulf Coast Assoc. Geol. Soc., Trans., v. 10, p. 77-85, 12 figs. incl. maps, secs., log, 1960, 3 refs.

Rayne field is located in the E.-central portion of Acadia Parish, Louisiana. The primary production from this field is gas condensate from multiple Frio [Oligocene(?)] sands ranging from the Marginulina texana zone to the Nodosaria blanpiedi zone. The important geological significance of this field lies in the pronounced effect on the stratigraphy and structure of 2 major down-to-the-S. depositional faults. Pronounced thickening of the stratigraphic section occurs on the downthrown side of both faults. The faults are of different ages, the northernmost fault on the N. flank of the Nodosaria structure being the oldest and influencing the older sediments from Nonion struma time to Nodosaria blanpiedi time, and the southern fault being the southern boundary of Nodosaria production and influencing primarily the younger sediments from Cibicides hazzardi time into Nonion struma time.--Auth.

3-1726. Eisenstatt, P. LITTLE CREEK FIELD, LINCOLN AND PIKE COUNTIES, MISSISSIPPI: Gulf Coast Assoc. Geol. Soc., Trans., v. 10, p. 207-213, 6 figs. incl. maps, sec., 1960, 2 refs.

The Little Creek field is located in S.-central Mississippi in the belt of production from the lower Tuscaloosa formation of Upper Cretaceous age. Prior to its discovery only 6 other fields in this trend in Mississippi were expected to produce relatively large quantities of lower Tuscaloosa oil (in excess of 10,000,000 barrels ultimate). The discovery well, completed in Jan. 1958, was located on the basis of geophysics. The field developed very rapidly, with 129 producing wells and 30 dry holes completed by the end of Apr. 1960.

Structural data show a gentle S.-plunging nose. Only 30 ft. of counter-regional dip is present; however an oil column of about 110 ft. is known, indicating the presence of a combination structural-stratigraphic trap. The producing sand body is irregularly shaped both as to area and thickness. The thickest known occurrence of the sand is 81 ft., and it often thins abruptly to zero in relatively short distances.

The present daily average production is about 15,000 barrels of oil or 127 barrels daily per well, and the ultimate production should be on the order of 25,000,000 barrels of oil.--Auth.

3-1727. Reagan, M. A., Jr., and Roscoe T. Foust, Jr. DISCOVERY AND DEVELOPMENT OF THE PERSON FIELD, KARNES COUNTY, TEXAS: Gulf Coast Assoc. Geol. Soc., Trans., v. 10, p. 25-31, 8 figs. incl. maps, secs., logs, 1960.

Person field is significant principally because it has proven the presence of oil accumulation in commercial quantities in the downdip portion of the Edwards trend.

The field is similar to other well-known Edwards limestone fields [Cretaceous] of S. Texas, in that it produces on the upthrown side of a N.-dipping fault which faults the upper Edwards against the impervious Georgetown limestone. The productive section in the Person field consists of the upper 200-350 ft. of the Edwards. This section is characterized by streaks of porous limestone with considerable fracturing and vugular to intergranular porosity separated by sections of hard dense limestone with no measurable porosity or permeability. Three productive sections tested in the discovery well have average porosities of 11-13% and average permeabilities of 11-12 millidarcies. A definite gas-cap approximately 200 ft. thick has been established. The oil column appears to have a thickness of 100 to 150 ft. With the existence of the thick gas-cap, high ratio problems have been fairly common and thus have complicated completions.

The field is still in the process of development, and the limits have not been defined; however, as this paper is written, the field extends 4 mi. in a NE.-SW. direction and approximately 1 to 1 1/2 mi. in a NW.-SE. direction. Sixteen wells have been completed, 5 wells are drilling, and one is testing. --Auth.

3-1728. Martinez, Anibal R. AN ANALYSIS OF THE FUTURE DEVELOPMENT OF THE PETROLEUM INDUSTRY IN VENEZUELA: GeoTimes, v. 5, no. 6, p. 17-20, graphs, table, March 1961, 14 refs.

Methods of analysis for the future development of the Venezuelan oil industry are presented. Curves are plotted representing the mathematical values determined by means of the integral prediction technique. Principal interpretations are that: the hypothetical final year of production is 2016; half the development of the industry will occur in the year 1965 when proved reserves will attain a maximum of 22 billion barrels; the maximum rate of discovery comes in 1960 and the maximum rate of production in 1971, both of which are 3.55 billion barrels per year.--M. Russell.

3-1729. Bigart, Homer. AUSTRALIA'S HOPE: OIL DOWN UNDER: New York Times, v. 110, no. 37,654, sec. 3, p. 1, col. 2, p. 22, col. 2-3, Feb. 26, 1961.

Although most geologists in the area are convinced that there is oil in Australia, there has been but one isolated find. Extensive prospecting has likewise proved fruitless in New Guinea. Recent discoveries of Fe ore in the Port Hedland area of western Australia has prompted the government to lift the embargo on Fe ore exports.--M. Russell.

3-1730. Bogolyubova, L.I. THE QUESTION OF THE DEGREES OF CARBON-FIXATION AND THE STAGES OF DEVELOPMENT OF THE BROWN COALS: Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in translation, v. 125, no. 1-6, p. 228-230, table, March-Apr. 1959, pub. 1960, 8 refs.

Petrographic and chemical methods have been used to study transitional features between peat and brown coal. Petrographic features are only useful for distinguishing peat, soft brown coal, and hard brown coal (lignite). For effective determination of the degree of C fixation in the brown coals, determination was made of the refractive index of the vitrain separated from the coal. Coagulation limit and humic acid content are supporting features.--F. Manheim.

14. ENGINEERING GEOLOGY

See also: Geologic Maps 3-1395, 3-1396.

3-1731. Demirel, T., and Donald Thomas Davidson. STABILIZATION OF A CALCAREOUS LOESS WITH CALCIUM LIGNOSULFONATE AND ALUMINUM SULFATE: Iowa Acad. Sci., Proc., v. 67, p. 290-313, 6 figs., 6 tables, 1960, 46 refs.

This paper describes a promising method of stabilizing calcareous Wisconsin-age loess with a combination treatment of spent sulfite liquor and aluminum sulfate. The stabilization is thought to be due to formation of water-insoluble basic aluminum lignosulfonate in the compacted soil.--Auth.

3-1732. Short, Nicholas M. PROJECT COWBOY. FRACTURING OF ROCK SALT BY A CONTAINED HIGH EXPLOSIVE: California, Univ., Radiation Lab., [Pub.] UCRL-6054, 60 p., 33 figs. incl. illus., diags., table, Nov. 1960, 3 refs.

On Feb. 20, 1960, 1,000 lb. of Pelletol high explosive was detonated in salt as part of Project Cowboy, an AEC-sponsored study of seismic decoupling of explosions. The detonation was contained in a tamped 3.0- x 4.5-ft. cylinder drilled within a salt dome mined by the Carey Salt Co. near Winnfield, Louisiana. In Project Plowboy, a Plowshare program for examination of explosion-induced fracturing of salt, the effects of this 1,000-lb. explosion were investigated by mining directly into the cavity region.

The 1,000-lb. explosion increased the maximum diameter of the cylindrical cavity by 60% and enlarged its volume by more than 2. The salt failed close-in by conspicuous plastic deformation, but shows no crushing. Numerous open fractures extend into the salt for a foot from the cavity surface at a frequency of 4 to 8 fractures/ft^2. Failure beyond this inner zone is by tensional fracturing; the fractures are now closed and about 1/32 in. wide. The frequency of fractures decreases at 10 ft. to around 1 per sq. yd. A few fractures extend to 20 ft. or more from the cavity; 1 fracture has been traced for 45 ft.

With one exception all known fractures were C-filled. Several fractures clearly show the role of cleavage in localizing failure. Elongate cleavage blocks in the fracture plane form a lineation which trends directly toward the cavity. Anhydrite banding in the salt exercises no control on orientation or position of fractures.

Away from the immediate cavity, vertical fractures radial from the cavity dominate. Two sets of low-angle fractures emanate from the cavity roof to form cones, each with apex pointing downward into the cavity. Very few fractures occur above the cavity roof or below the cavity floor; local shearing does develop in the roof.--Auth.

3-1733. Dickens, H.B. EXPERIENCE WITH A PIER-SUPPORTED BUILDING OVER PERMAFROST: Am. Soc. Civil Engineers, Soil Mech. & Found. Div., Jour., v. 86, no. SM5, pt. 1, p. 1-14, 9 figs. incl. 5 illus., diags., Oct. 1960, ref.

The construction of a 2-story steel frame building over permafrost at Churchill, Manitoba, during 1948-1950 is described, and its performance is discussed in relation to the construction techniques used. Its apparent satisfactory performance after 9 years of occupancy suggests that the concrete pier and spread footing foundation used can be a practicable alternative to embedded foundations for large heated structures in permafrost regions.--Auth.

3-1734. Cooke, J.B., and J.E. Schumann. UNDERGROUND OUTLET WORKS FOR COURTRIGHT AND WISHON DAMS: Am. Soc. Civil Engineers, Hydraulics Div., Jour., v. 87, no. HY1, pt. 1, p. 27-40, 5 illus., map, diags., Jan. 1961, 4 refs.

The diversion and outlet tunnel for Courtright dam [Sierra Nevada Mountains, E. of Fresno, California] is in competent granite. It is unsupported and unlined. The outlet tower and trashrack are submerged. The outlet control is located in the tunnel at the axis of the dam and consists of 1) a pipe embedded in a plug, 2) a butterfly valve in a dry chamber, 3) a cone-dispersion valve in a discharge chamber, and 4) an air-vent access shaft, Wishon dam outlet works are similar.--Auth.

3-1735. Lane, K.S., and R.G. Fehrman. TUTTLE CREEK DAM OF ROLLED SHALE AND DREDGED SAND: Am. Soc. Civil Engineers, Soil Mech. & Found. Div., Jour., v. 86, no. SM6, pt. 1, p. 11-34, 11 figs. incl. 4 illus., diags., graph, Dec. 1960, 10 refs.

To fit available materials, the design of Tuttle Creek dam in central Kansas includes major volumes of shale-limestone constructed as a rolled fill, and of sand deposited by dredging directly into place 2 types of fill not commonly employed in present-day earth dam construction. The reasons for choosing this design are explained, together with experiences learned during construction. The paper covers primarily the earthwork and foundation aspects of the project, of which the other more unusual features are closure "in the wet" and handling an area of weak clay foundation partly by excavation and partly by exceptionally wide berms.--Auth.

3-1736. Johnson, Henry S., Jr. UNDERGROUND STORAGE OF NATURAL GAS IN SOUTH CAROLINA:

South Carolina, State Devel. Board, Div. Geology, Geol. Notes, v. 4, no. 6, p. 49-51, map, Nov.-Dec. 1960, 2 refs.

As yet there are no known oil or gas fields in South Carolina. All natural gas used in the state is brought in by pipeline from sources in Louisiana and Texas. Potentially the state may also be supplied by barge or tanker through the ports of Beaufort, Charleston, and Georgetown. There is also a possibility that the current increased interest in exploration for oil and gas along the Atlantic Coast may lead to discoveries of natural gas in the coastal areas of South Carolina or adjacent states.

Underground storage for natural gas has not been developed in South Carolina to date, but considerable thought has been given to the feasibility of it. Geologically, there are 3 possibilities. These are caverns in granite and gneiss of the Piedmont, caverns in the Cooper marl (Eocene-Oligocene) near Charleston, and water sand storage in the lower Coastal Plain.--Auth.

3-1737. Mansur, Charles I., and R.I. Kaufman. DEWATERING THE PORT ALLEN LOCK EXCAVATION: Am. Soc. Civil Engineers, Soil Mech. & Found. Div., Jour., v. 86, no. SM6, pt. 1, p. 35-55, 9 figs. incl. diags., graphs, 4 tables, Dec. 1960, 2 refs.

Thirty-six large-diameter deep wells were installed around the top of the excavation for Port Allen lock [Mississippi River across from Baton Rouge, Louisiana] for the purpose of lowering the hydrostatic head in the deep stratum of pervious sand that lies beneath the lock. Specifications for the project required that the number, arrangement, and capacity of the wells and pumps be capable of reducing the hydrostatic head in the deep sands to a level of 5 ft. below the bottom of the excavation (about el - 26 m. l.g.) with a river stage of 45 ft. mean low gulf (m.l. g.). It was required that the ground-water table in the excavation areas and behind the excavation slopes be lowered as was needed for satisfactory construction operations. After completion of the excavation to within 5 ft. of grade, the water table in the foundation was to be maintained 5 ft. or more below the bottom of the excavation until construction work would permit flooding the structure. Approval of the dewatering system was contingent, in part, on its proven performance. After installation of the deep well system, tests were made to determine its adequacy.

The observed test data indicated that the 30 temporary and 6 of the 8 permanent wells would be adequate for controlling the hydrostatic pressure in the deep sands beneath the main portion of the excavation for river stages up to el - 45. Lowering the head in the deep sand below the bottom of the excavation for a river stage of 45 m.l.g. would require a pumping rate of about 45,000 g.p.m. This corresponds to an average flow of about 1,250 g.p.m. per well. The total well flow was about 500 g.p.m. per ft. of average drawdown. The permeability of the deep sand stratum as computed from the observed well flow and piezometric data was about 700 x 10^{-4} cm. per sec. Lowering the hydrostatic head in the deep sand stratum below the bottom of the excavation had little effect on drying the excavation slopes and the bottom of the excavation. The 3-stage wellpoint system installed for lowering ground-water level beneath the slopes and excavation proved satisfactory for this purpose.--Auth.

3-1738. U.S. Army, Corps of Engineers, Tulsa District. REPORT ON SECOND RESURVEY OF SEDIMENTATION, DENISON DAM AND RESERVOIR (LAKE TEXOMA), RED RIVER, TEXAS AND OKLAHOMA: 16 p., 72 pls., 5 tables, Oct. 1960.

The survey shows a total of 306,000 acre-ft. of sediment deposited in the reservoir in the 11.9-year period of record. Sediment has depleted the flood-control pool 1.21%, the power pool 8.27%, and the dead storage pool 9. 42%. The total capacity of the reservoir at spillway crest has been depleted 5.22% in the 11.9-year period. About twice as much water and sediment per square mile of drainage area is contributed to the reservoir from the Washita drainage basin as from the Red River drainage basin. The average rainfall and runoff over the watershed during the period of sedimentation in the reservoir have been approximately the same as the averages for the period of record. Degradation in the 101 river mi. below Denison dam had caused the removal of more than 36,000 acre-ft. of river bed and bank material by Dec. 1958.--Auth. summ.

3-1739. Peyronnin, Chester A., Jr. HYDRAULICS OF SOUTHWEST PASS, MISSISSIPPI: Am. Soc. Civil Engineers, Hydraulics Div., Jour., v. 87, no. HY1, pt. 1, p. 103-113, 9 figs. incl. map, graphs, Jan. 1961, 4 refs.

This paper summarizes and generalizes the results of an extensive data collection program at Southwest Pass of the Mississippi River. Various theories of shoaling in highly stratified estuaries are examined and the salt water wedge theory selected as the most probable cause of heavy shoaling in this pass.--Auth.

15. MISCELLANEOUS

3-1740. Grabau, Warren E. GEOLOGY AS AN HISTORICAL TOOL: Gulf Coast Assoc. Geol. Soc., Trans., v. 10, p. 87-91, 1960.

Geology is at best a synthetic science; the general geologist must have a working knowledge of chemistry, physics, biology, mathematics, and many other sciences. This training in a spectrum of skills makes the geologist peculiarly fitted to deal with multiple-variable problems, especially those which can be reduced only to qualitative solutions. Such problems are numerous in historical criticism; history, like geology, is a reconstructive art involving the interplay of large numbers of variables. Many otherwise incomprehensible events, particularly in military history, become logical and understandable when methods of inquiry based on geological information and techniques are applied. Such examples from the Civil War in the Vicksburg area include the location of the ironclad gunboat Cairo, the nonintervention of the Confederate trans-Mississippi armies in Grant's march through Louisiana, Grant's decision to march far inland in Mississippi after the battle of Fort Gibson, and several others. Based on such examples, it seems obvious that geologists are not exploiting their peculiar skills to a maximum.--Auth.

3-1741. Karo, H. Arnold. GEOLOGIC ASPECT OF COAST AND GEODETIC SURVEY OPERATIONS: GeoTimes, v. 5, no. 6, p. 8-13, 38-43, 3 illus., map, chart, March 1961.

The U.S. Coast and Geodetic Survey has had a general reorganization to extend and exploit its scientific and technological potential. The enlarged scope of operations intensifies phases of the work concerned with geology. Especially pertinent are earth measurements obtained in geodetic, hydrographic, and topographic operations. Contributions from the Survey of a scientific nature fall into 3 classifications: 1) the collection and dissemination of basic physical data, 2) byproducts of Bureau operations for utilitarian purposes, and 3) contributions emanating from the use of scientific methods in the work whose developments from time to time brings unexpected additions to scientific knowledge. Specific contributions include the Crater Lake, Oregon, survey; bathymetry of the Georges Shoal off New England; charting of seamounts S. of Alaska; study of the continental margins; detection of earth movements through geodetic measurements; gravity determinations; and seismological studies.--M. Russell.

3-1742. California, Division of Mines. FIFTY-SIXTH REPORT OF THE STATE MINERALOGIST: 219 p., illus., maps, graphs, tables, San Francisco, 1960.

This volume contains the Annual Report of the State Mineralogist, Chief, Division of Mines, for the 110th fiscal year, 1958-1959, by Ian Campbell and Staff; Summary of Work in California by the Geologic Division, U.S. Geological Survey, by Charles A. Anderson; California Mineral Commodities in 1958, by Henry H. Symons and Fenelon F. Davis; Directory of California Mineral Producers, Dealers, and Laboratories, 1959, by Henry H. Symons and Fenelon F. Davis; Metal, Mineral, and Mineral Fuel Review for 1958, by Charles W. Merrill and others.

3-1743. Johnson, Henry S., Jr., GEOLOGIC ACTIVITIES IN SOUTH CAROLINA DURING 1960: South Carolina, State Devel. Board, Div. Geology, Geol. Notes, v. 5, no. 1, p. 1-6, Jan.-Feb. 1961.

During 1960 the Division of Geology, South Carolina State Development Board, continued its investigations of the geology and mineral resources of the state with a staff of one full time geologist, one geologic secretary, a ceramic consultant, and 9 part time geologists and geologic assistants. Investigations under way included studies of limestone resources of the Coastal Plain; the minerals industry of the state; geology and mineral resources of Edgefield, Pickens, Newberry, Orangeburg, and York counties; fullers earth type shales; bentonitic clays; Cooper marl; Waccamaw and Croatan deposits; and the geology of the Fort Jackson North, Blaney, Irmo N.E., and Blythewood quadrangles. Reconnaissance investigations were made of individual gabbro, Mn, Au, kaolin, sand, and bloating shale deposits. Six issues of Geologic Notes were published. These issues contained articles on geologic activities during 1959, brick clays, Oligocene fossils, the Kings Mountain belt, heavy minerals on Hilton Head Island, kyanite, gabbro, foundry sand, the Blaney quadrangle, and underground storage for natural gas.

Mineral production in South Carolina consisted principally of mining clay and limestone for cement, stone for crushed and dimension stone, kaolin, sand, gravel, and vermiculite.--Auth.

3-1744. Chao, Edward C.T. GEOLOGY IN COMMUNIST CHINA, 1960: GeoTimes, v. 5, no. 6, p. 14-16, March 1961.

Prior to 1950, China had about 200 active geologists. By 1954 the number of "geological workers" had increased to 900, and by 1960, to 21,000. The Ministry of Geology was established in 1952. More than a dozen important institutes were established in 1956 and 1957 as part of the first 5-year plan. In 1959, there were about 19,000 geology students in the high-level technological schools, and about 25,000 students in the intermediate level geology schools. Some progress has been made in regional geologic study and mapping. Many new and large mineral deposits have been discovered. The reserves of Mo ores in China are now rated highest in the world. Although much geologic data has been accumulated, the science is still in its infancy. More than 400 Russian geologists and engineers have visited China in the last decade and their influence is strong.--M. Russell.

3-1745. National Academy of Sciences-National Research Council. SCIENCE IN ANTARCTICA - THE PHYSICAL SCIENCES IN ANTARCTICA. Part II of a report by the Committee on Polar Research: Its: Pub. 878, 131 p., maps, profiles, graphs, tables, 1961, refs.

This volume undertakes an appraisal of present knowledge in the Antarctic for various physical sciences and considers desirable objectives for future research programs (Pt. 1 of this report covered the life sciences). Sec. 1 deals with the heat and water budget of Antarctica - meteorology, oceanography, and glaciology. Sec. 2 concerns the earth's crust and core and includes geodesy and cartography programs; gravity measurements; earthquake seismological investigations; Antarctic traverse seismology program; seismological crustal studies; magnetic program; research and problems in geology; the IGY interdisciplinary program in earth sciences. Sec. 3 covers upper atmosphere programs. --A.C. Sangree.

3-1746. Crary, A.P. STATUS OF UNITED STATES SCIENTIFIC PROGRAMS IN THE ANTARCTIC: Am. Geophys. Union, Trans. v. 41, no. 3, p. 521-532, 2 maps, table, Sept. 1960; also pub. as: Natl. Acad. Sci., IGY Bull., no. 39.

Administration of the United States Antarctic Research Program since the close of the International Geophysical Year was shifted from the National Academy of Sciences and its U.S. National Committee for the IGY to the National Science Foundation, with Thomas O. Jones, Program Director. The program is arranged in consultation with the Committee on Polar Research, with coordination of governmental agencies through the Interdepartmental Committee on Antarctic Research. The International Council of Scientific Unions established the Special Committee for Antarctic Research in Feb. 1958 as one of several groups to coordinate the post-IGY effort. The program now consists of research at 6 Antarctic installations. Byrd, South Pole, and McMurdo stations are wholly U.S.; Hallett is conducted cooperatively with New Zealand, Ellsworth with Argentina, and Wilkes with Australia. Approximately the same number of personnel is maintained as during IGY, with additional emphasis on biology and on geology, which was not an IGY discipline but on which preliminary information was obtained by personnel of other disciplines.

Windmill Islands consist of Precambrian metamorphic and igneous rocks. The Dufek massif is a basic igneous complex with horizontal layering. The Sentinel Mountains are strata strongly folded with N. trend; their relationship to the Antarctic Andes is unknown. The Horlick Mountains are block-type with little disturbed Lower Devonian marine strata lying unconformably on basement complex. The Executive Committee Range, Toney Range, and Peter I Island are volcanic basalt. Thurston Island is diorite gneiss cut by dikes. South Victoria Island was studied by geologists the past 2 summers. In W. Antarctica a major sub-ice channel was located between the Ross and Bellingshausen seas. Much of this data was obtained during oversnow traverses, which total 16,500 km. and which have also yielded much data on glaciology, including ice thickness, temperature, and movement. The Snow, Ice and Permafrost Research Establishment of the U.S. Army has analyzed cores from holes drilled as much as 300 m. deep. Oceanographic data was collected during 1959-1960 by U.S. Navy Hydrographic Office during 16,000 mi. of sonic soundings, 4,000 mi. of pack-ice reconnaissance, 7,000 mi. of continual surface temperatures, 1,000 bathymetry lowerings, and 15 bottom-core samples. The research vessel Vema of the Lamont Geological Observatory, Columbia University, not able to cruise in ice-covered waters, in 1960 studied submarine geology with aid of ocean-floor photography, dredging, seismic techniques, and cores (up to 20 m. long), between Australia and South America N. of the ice pack. Seismology equipment is operated at Byrd, South Pole, Hallett, and Wilkes stations. Antarctica is not an active seismic region. Continental structure appears to be limited to E. Antarctica.--A.C. Mason.

3-1747. Caldwell, Loren T. THE NEW ROLE OF EARTH SCIENCE IN EMERGING SCHOOL SCIENCE PROGRAMS: GeoTimes, v. 5, no. 6, p. 26-28, March 1961.

Six years of patterned descriptive science for the kindergarten through 6th grade should prepare the 7th grade student for his new semiquantitative science learning experiences. These consist of new mathematical learnings, and 2 concurrent science learning sequences of natural laws in biology and physics-chemistry. An effective earth science course for 9th grade and a dynamic course in ecological biology for 10th grade should give the kindergarten-10th grade science program the punch which present society is requiring of its good citizens and lead to the recruiting of more capable science students for special science education in the senior high school 11th and 12th grades. Some ways are cited by which an earth science course in the 9th grade can strengthen the general education science curriculum.--From Auth. summ.

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